THE

ELECTRICAL REVIEW.

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SUPERHEATING.

THAT initial cylinder condensation greatly reduces the efficiency of the steam engine is well known, but it is not so well known that wet steam seriously intensifies all those losses that arise from the thermal transferences between the cylinder metal and the steam. Superheating has for long been held up as a means to economy, but its use was given up almost without a struggle about the time that the compound engine became common, and was due partially to the evil effects of superheating upon animal fats used for cylinder lubrication. The fats decomposed to acids, and the corrosive action of acids was debited to temperature. Now that mineral oil is universal, we shall see—are already seeing—a recrudescence of superheating. It would be almost better to say steam drying, for in the case of a recent successful application of superheaters to water tube boilers the amount of superheat is only 9° or 10° F. But how great was the percentage of wetness cannot be known, and it is rather in the total abolition of wetness than in any serious superheating that such good results are shown by the superheaters at the works of the Charing Cross and Strand Electric Light Company, where the chief engineer, Mr. W. H. Patchell, has applied the McPhail and Simpson heater to two out of seven boilers, and realised an economy of 5 per cent., which is, we may suppose, equivalent to a 15 to 17½ per cent. saving if the heaters were applied all round. The superheater consists of a large number of 1-inch pipes, placed in a hot portion of the flues. The steam is led through these pipes direct from the usual anti-priming pipe, and it next flows through another set of pipes immersed in the water of the boiler. The idea of these latter pipes appears to be, to use Mr. Patchell's words, to take the sting out of the steam—that is, to prevent too high a temperature. Dryness is ensured, and even a moderate superheat, and there can hardly be two opinions as to the great need for some excess above the heat of saturation to make up to some extent the radiation losses of the steam pipes. With a superheater a boiler may be forced heavily and made to prime; the priming will be evaporated, and in this way Mr. Patchell has found that fitted boilers may be forced to an excess of 50 per cent. beyond the unfitted boilers.

With superheaters not in use, the temperature on the engine side of the stop valve showed from 6° to 7½° less than boiler temperature, while, when the superheaters were on, the temperature was about 9° or 10° above the boiler. We should judge from this that the stop valve caused a reduction of temperature, so that the true amount of superheat would be the sum of the above figures, or from 15° to 17°. The lesson to be drawn from this single experience is confirmatory of our opinion that if engineers would take steps to dry their steam, they would secure very desirable economies, even without many degrees of actual super-

heating, and the vexed question of determining the dryness factor of steam would solve itself in absolute dryness. Needless to say the steam, before passing through the second set of tubes, is really very much superheated, the temperature being found above 600°. Hence the need for these tubes being small, and the necessity of the second set to take out the excess of superheat.

We think that as a superheater the apparatus has proved itself exceedingly satisfactory. The only point which seems to be doubtful is that of incrustation. When a boiler primes some of the salts contained in the water may be carried over with the steam, and will be deposited in the superheater tubes. Soluble salts can be washed out of the tubes by fresh water when necessary, but the insoluble lime salts will gradually accumulate until the tubes become choked or burned out. Not that this ought to tell against a superheater, for there ought to be no lime salts in a boiler with suitable external purification, or, at least, the quantity should be minimised.

The Borchers Battery.

So many contradictory results have been obtained by those experimenters who have tested this battery, since Dr. Borchers's description of his invention was first published, that it appears to be necessary to suspend our judgment of its practical value till the inventor has completed and tested the large battery, in the construction of which, we understand, he is at present engaged. Dr. Borchers, in reply to his critics, asserts that none of them have exactly fulfilled the conditions of his original experiment, and, therefore, could not expect to get the same results. Besides, it may be true, as many experimenters have maintained, that the direct source of the E.M.F. is the oxidation of the copper; yet if the carbonic oxide comes in to reduce the oxide formed, the latter may still be looked upon as the ultimate source of the energy. Mr. Carl Hering, who is inclined to the view that success is likely to be attained by some indirect method of causing oxidation of the fuel gas, describes an interesting experiment made by himself and Mr. von Dobrowolski some years ago, which appears to show that a cell can be made to generate current by the cold combustion of coal gas. Two battery carbons were carefully cleaned and platinised with platinum black; they were then placed in dilute sulphuric acid and kept short-circuited for some time in order to discharge them. One was then placed in a jar containing ordinary illuminating gas from the street mains, and the other held in the air. After a while, they were again inserted in the sulphuric acid and connected to a crude galvanometer. By making and breaking the circuit at proper intervals, the needle of the galvanometer could be made to spin round. Exact measurements were not made, but it would be well if some precise determinations of the E.M.F. and resistance of this interesting gas battery were forthcoming.

Water on the Brain.

It is a common sight now to see a kettle boiled or a chop cooked by means of a small fine wire resistance through which an electric current is passed. This, and the fact that every one is now talking about frozen water pipes has led Mr. C. Hyatt-Woolf to the conclusion that what is "sauce for the goose would be sauce for the gander," and accordingly he suggests in the *Standard* that a similar arrangement should be used in water-pipes so that when they froze, a current could be sent along an insulated wire passed through them, by which means the ice would be melted at once. It sounds delightful, though no particulars are given as to how the idea could be carried out in practice. The similarity of the writer's name with that of one of the editors of a weakly pen'north led us to believe for the moment that the proposal emanated from the latter, but as we observe it stated in its columns that very few electrical journals can reply to electrical questions with the conciseness and accuracy which distinguishes everything strained through the scientific sieve he helps to shake, we are constrained to think that the *Standard's* correspondent is one of those irresponsible individuals who are always so ready to write about things they don't understand. The first question would be how much frozen water is there in the pipe, and then the electrical cookery people could soon tell us what it will take to thaw it. Suppose the pipe is 50 feet long and 1 inch internal diameter, we get a little less than 600 cubic inches of water, or one-third of a cubic foot as its contents—this is about 2 gallons, or 20 lbs. It requires a H.P. minute to raise 22 lbs. of water 1 degree C., consequently to boil this water or furnish the heat to properly thaw the ice, about 100 H.P. minutes would be needed, or 1 H.P. for an hour and three-quarters, that is about eightpence worth of current at 6d. per Board of Trade unit. If the current were taken off the supply mains 13 ampères would be needed for an hour. A return circuit would probably be needed to prevent electrolytic action; to insulate the wire it might be strung with a row of glass beads close together. But we weary our readers, and, therefore, conclude with the suggestion that in the first place the efforts of scientists would be better directed to ascertaining how deep a month's hard frost penetrates in different soils, and in the second that the energies of the water companies and the capital required for electric appliances would be more economically expended in burying the supply pipes below that depth and seeing that they are well protected when they enter houses, and, perhaps, in addition fixing a small cock in a suitable place, which could be safely left running full bore, without overtaxing the companies' powers of supply. Was it not in the *Standard* some weeks since that their St. Petersburg correspondent wrote an article on the water pipes there, and said they hardly ever froze under ten times worse conditions than in England.

A Modern Sturgeon.

The citizens of Dublin have received a solemn warning of the dangers they will incur by the introduction of electric traction into their streets. In a letter to the *Irish Times*, Mr. John Sturgeon, of Leeds, records some remarkable occurrences in connection with electric traction in America, which, if true, would lead the citizen of Dublin to suppose that he can only enjoy the advantages of electric transit at the cost of converting his home into a sort of powder magazine. In one case, recorded by Mr. Sturgeon, crossing gas and water pipes brought into contact by the vibration of the street, struck an arc, burnt a hole in the gas pipe, and set a house on fire. This tale appears on the face of it to be improbable, and, for an American yarn, incomplete, since we would expect that the arc would next have burnt a hole in the water-pipe and extinguished the fire. "In another case, a plumber had occasion to cut a water-pipe in two, when an electric arc formed at once between the severed ends." The severed ends of the water-pipe were both to earth, and yet we have to believe that there could have been a potential difference of 20 or 30 volts between them! These and other tales, possessing all the characteristic exaggeration of American humour, appear to have been seriously accepted by Mr. Sturgeon as facts. Nor are we surprised at Mr. Sturgeon's inability to discriminate between the true and the false in these questions when we come to read his views on the laws of electric currents a little further on. The resistance of electric conductors, according to Mr. Sturgeon, is proportional to the square of the velocity (of electricity), "and will be four times as much for two cars as for one." "The electric current naturally follows the line of least resistance, and when the rails become surcharged as it were, it seeks other outlets along pipes and other buried metal work. As these in time lose their conductivity by corrosion the current wanders off through service pipes into houses, &c." Mr. Sturgeon's misconception of the action of currents on gas and water-pipes, appears to be equalled only by his ignorance of the simplest laws of electricity. It is difficult to imagine that anyone, in these days of cheap text-books and technical schools should be able to retain such fallacious ideas, that he should pose as an instructor of the public is incredible. That return earth currents produce at certain points increased corrosion in pipes we explained in our last issue, but we also showed that there are simple means known to electrical engineers by which this injurious action can be prevented.

WAVES AND VIBRATIONS.—II.

Lord Rayleigh opened his second lecture by a repetition of the experiment with the circular tank, in which waves were excited having the nodes circular. The time and number of vibrations were recorded with the assistance of certain members of the audience. Mr. Alexander Siemens differing in his figures from Mr. Gordon, who assisted the lecturer in these experiments, a slightly lower number was obtained than the 95½ complete swings per minute which had been observed when arranging the experiment. Lord Rayleigh pointed out that any number of vibrations may go on at once, those of one kind being superimposed upon the others. A familiar instance is that of an orchestra in which a harmonious blending of the different notes takes place. When, however, the vibrations become extremely great there is a departure from this law.

Referring again to progressive waves of different kinds, in sound the particles travel in the same direction as that of the waves. In the case of light travelling, say, horizontally and towards the north, the direction of the vibrations may either be vertically, or horizontally and from east to west, at right angles to the direction the waves are progressing. In water there are usually two motions. Thus in fig. 3 the water particles have a combined vertical and horizontal motion. The motion is greatest at the surface, below the surface it is still in circles, but smaller in amount. A few wave lengths down motion ceases, it is practically limited to the surface of the water, and when motion begins to fall off it does so with great rapidity, but the distance it penetrates depends on the wave length. Geologists may have omitted to consider the motion of shells on the bottom of the sea. The fact is due to wave motion; alternative motion is much more potent to affect bodies at the bottom of the sea than the kind of motion in tidal rivers where a stable position is probably

Fig. 3.

Fig. 4.

Fig. 5.

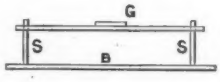


Fig. 6.

Fig. 7.

obtained. The genesis of waves by the action of the wind is a point somewhat obscure, but when waves have once been created, it is evident that the wind pressure upon the wave-mass must have a direct influence. If the wind is in the same direction as the wave motion, energy is given to the waves by the wind following them, and work will be done upon them. The waves will grow in energy and in intensity. If, however, the wind be in the reverse direction, it will, to use a nautical phrase, "knock the sea down." Fig. 4 indicates the first case referred to; the waves are supposed to be travelling from left to right, and the wind will act upon the rear portion of the wave-mass.

Besides great, small waves have to be considered. Mr. Thornycroft has stated that he has observed waves having a period as great as 15 seconds, on the other hand there may be waves so numerous that 1,000 go to a second. Such small waves are governed by capillary force. The certain size of waves for which the velocity of propagation is less than for any other size, is fixed by the following quantities:

Velocity of propagation	...	23 cm. per second.
λ (wave-length)	...	1·7 cm.
f (frequency)	...	13·6 per second.

Waves are small when capillary force predominates, and large on account of gravity. When two systems of waves are created by separate or distinct causes, they may set up stationary waves, or, as was shown by experiment, lead to resultant waves which progress slowly in one direction. The motion in this case would be towards the source of graver waves, using the word *graver* in the sense of lower tone, and this motion would be irrespective of the speed of either wave. By an application of this principle, capillary tension can be measured. Capillary tension is usually measured by the rise of liquid in a capillary tube, but an assumption has to be made as to what happens at the side of the tube, and one cannot be assured that the surface of the water is free from grease. A test for grease is to ascertain whether camphor particles retain their rapid motions, which take place when they are placed upon pure water.

Faraday used an apparatus to set up stationary waves, which depends upon vibration sustained in the same way as is the vibration of an electrically driven tuning fork. A horizontal bar carrying a glass plate, fig. 5, upon which the liquid to be experimented upon is placed, is maintained in vibration by a make and break arrangement in circuit with an electro-magnet. The water does not make the same vibrations as the bar, it vibrates an octave lower than the glass plate does. If the bar makes 20 vibrations per second, the water will make ten vibrations in the same time.

Lord Rayleigh threw upon the screen a slide showing the figures obtained with sand when subjected to this kind of vibration. A similar sort of motion is set up in the water contained in a wine glass when the edge is bowed or stroked with a damp finger. The lateral motion of the walls of the glass cause a horizontal and resultant vertical motion in the mass of water.

In the case of oblique waves caused by an obstacle, say, in flowing water, the point of intersection of the waves with the resultant through the obstacle travels more quickly than the waves themselves, fig. 7. Lord Kelvin calculated the minimum velocity of waves of this kind, the exact figures of which are given above, and it is to him that we are indebted for much that is known about this subject. Lord Rayleigh then stated that to vary the monotony and the dryness of this portion of his subject, which, by the bye, was not apparently perceived by the major portion of his audience, he would take up briefly the question how such vibrations and motions could be measured and recorded. The simplest way was to get an instantaneous picture of what was going on. The magnesium flash-light is useful for many purposes where absolute instantaneity is not required. That is to say, it lasts about one-tenth of a second, but there is one resource that never fails, and that is the electric spark. The spark is over in 10^{-6} second, and there are not many things which can do much in that time. It is turned to excellent account in all kinds of observations. One case particularly in point is, what happens when a fountain scatters. The extremely short duration of a spark was known long ago, and it was used largely by Prof. Roude in America some 20 years ago. Although not mentioned at the lecture, it is not inopportune to refer to Prof. Worthington's use of the "break-spark" to obtain photographs of drops falling upon liquid and metal surfaces. These experiments were shown at a Friday evening discourse in the same lecture theatre last session and form an excellent example of the kind of results obtained.

A still more powerful method consists in the use of instantaneous illumination, but applied in a different manner so as to show any moving object in one phase of its motion. The light is intermittent, being cut up as it were into slices, and any motion which departs but a little from the extreme stringency required can be detected, provided the flashes be more than about 20 per second, to which the eye is itself responsive. Anything more than this cannot be seen by the eye, below this figure an object looks quite "fuzzy." The intermittency of the light is obtained by a disc pierced with holes being rotated on the shaft of a small electric motor. It will be remembered that this method has received very careful attention at the hands of Major-General Festing and

Captain Abney in this country, who have made use of it in a slightly modified form for photometric work, and Prof. Nichols has also adopted a similar method in America for some of his researches upon the energy of different parts of the spectra from light obtained from different sources.

This method was also used by Prof. Boys to show the breaking of a soap film, which disappears in the $\frac{1}{200}$th to the $\frac{1}{300}$th of a second, the breaking up being started by dropping a shot wetted with alcohol through the film. In similar experiments the film was illuminated by the spark-light, and great care had to be taken to time precisely the instant at which the spark occurred. This, the second, lecture was of great interest to electrical men owing to the near relationship which exists between waves in ordinary matter and in tenuous matter. Lord Rayleigh is making the most of his subject, and the Saturday afternoon meetings are drawing a large number of very well known men to the Institution in Albemarle Street.

THE STORAGE OF ENERGY ESSENTIAL TO ECONOMY OF WORKING IN CENTRAL STATIONS*

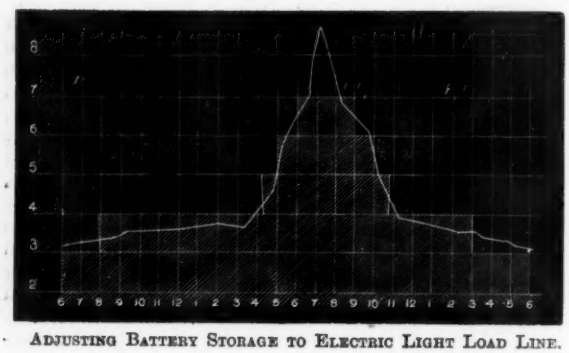
By N. W. PERRY, E.M., New York.

(*Continued from page* 317.)

In some cases where the day load is exceedingly light, it will not warrant the operation of the plant at all—the load costs more than it will bring in. In such cases there can be no question as to the economy of the storage battery, since it can be charged during the night by power that would otherwise be practically wasted, and during the daylight hours it may carry the whole load. In such cases it will effect an economy in another way also, viz., by carrying up to its capacity the peak of the load. The economy in this direction will be the greater the sharper the peak, and will disappear as this flattens out.

But the manner in which the storage battery is most frequently employed to advantage in a central station is by changing the load line from the irregular one, due to the natural load, to one which would be formed by a series of rectangles which would in the aggregate have about the same area.

I have endeavoured to illustrate this in the accompanying diagram. The irregular black line represents the natural



Adjusting Battery Storage to Electric Light Load Line.

load line. The spaces between the horizontal lines represent the units into which the equipment is divided, and the vertical lines the time at intervals of two hours.

Beginning at 6 a.m., the load is a little above the best output for 3 units, but without too much overloading these three units can carry it. The line gradually rises, however, until at 8 a.m. it becomes too much of an overload for three units. If a fourth unit were thrown in it would at first have to operate at only about one-third load, and hence very uneconomically. A storage battery load sufficient to make up a full load for this unit would, therefore, be thrown in at 8 a.m., and the new unit would thus work economically from the start. The part of the load furnished by the battery is represented by the shaded portion outside the natural load line—that is to say, this much energy is being absorbed by the battery, and will be available at another time—less the loss due to inefficiency of the battery. I have assumed a battery efficiency of 75 per cent. We see from the diagram that the battery is charging 8 a.m. to about 4 p.m.; 25 per cent. of the energy *thus* stored will therefore be lost. It will be apparent that this bears no relation whatever to the total amount of energy being generated at the time, for units 1, 2, and 3 are working directly into the feeders, and are not affected at all. The energy thus lost bears an exceedingly small ratio to the total energy generated.

At 4 p.m. the natural load consumes all the energy of the third unit, and in about 20 minutes has increased so as to be an overload. Now it depends upon circumstances whether we will bring our stored energy to the assistance of the fourth unit to carry the increasing load further or not. For the purpose of illustration, I have assumed that we will not, but will throw in our fifth unit and complete its load by charging the battery. At ten minutes to five the load line crosses the fifth unit line, rising very rapidly, and the same question arises again, but I throw in my sixth unit at once, completing its load; the shaded area outside the natural load line again being the energy taken by the battery, 75 per cent. of which will be available. At 5.30 the load exceeds the normal capacity of all six units, but the diagram represents them as carrying the increasing load until 6 p.m., when the seventh unit is thrown in, and the load completed by the storage battery until 6.40, when the natural load requires the whole attention of all seven units.

Now the question arises, will it be necessary to add first an eighth and then a ninth unit to take this peak? If so, it will add considerably to the fixed charges on our power account. Will it be cheaper to supply battery capacity to carry this peak? That is a question to be decided separately for each individual case. Storage batteries will stand an abnormal discharge for a short time without serious injury. Some will stand it better than others. If it be too rapid the depreciation charge will be increased, also if this abnormal discharge be continued too long. Then, too, at rapid discharge the battery becomes less efficient and the loss will become greater than 25 per cent. It is only by balancing these losses against the advantages that the question can be decided whether it will be more advantageous to throw in an eighth unit and let the battery take care of only the tip of the peak beyond that, or let the battery take the whole of the peak beyond the seventh unit line. In the diagram I have assumed that the latter is more advantageous. The battery, therefore, discharges until 8.20, when it begins to recharge, supplementing the seventh unit load until 9 p.m., when the seventh unit is thrown out entirely, and the battery carries the remaining seventh unit load until 9.25, the battery load being represented by the unshaded triangle within the load line. And so the battery and units continue supplementing each other throughout the remaining hours.

In this way the battery will prove economical with some curves. In others it may not; but whether or not, it will depend upon so many contingencies, that it is utterly impossible to state *à priori*. There are other considerations than economy that might balance its absence, such as convenience as a regulator of potential; the facility it affords for distribution to sub-stations at high potential, resulting in an economy of copper, and the subsequent transformation down for local distribution, and some others which will suggest themselves. Some of these might be controlling in special cases.

Then, on the other hand, the employment of the storage battery is limited entirely to the storage of energy when generated in the form of electricity; not only this, but it is still further limited to direct currents, and is therefore of no avail in stations sending out alternating currents.

Gas Storage and Gas Engines.

For strictly power purposes the use of gas engines is now, more than ever before, attracting attention, and abroad the

* Read before the National Electric Light Association at its 18th Convention, held at Cleveland, Ohio, February 19th, 20th, and 21st, 1895.

gas engine has already found its way into the central station and it has made its bow here also.

On purely theoretical grounds at least the gas engine deserves our consideration at this point for the following reasons: In the first place, we may replace the wasteful standby losses of steam boilers under the variable central station load by the ideally simple and economical system of gas storage. The use of the gas engine, therefore, comes legitimately within the province of this paper, since it permits of employing a substitute for the boilers, which may be operated continuously at the most economical load, and yet supply with equal efficiency the most variable load that can possibly be thrown upon it.

Comparing the relative theoretical advantages of the gas engine and the steam engine, Professor Kennedy states that the maximum theoretical efficiency of the steam engine is 30 per cent. Its obtained efficiency is about 10 per cent. The theoretical maximum efficiency of the gas engine is 80 per cent. Its efficiency obtained in practice is 25 per cent. These facts have led Mr. Thwaite to say that the practical efficiency of the gas engine is equal to the theoretical efficiency of the steam engine. As a matter of general experience, however, under usual working conditions with large engines, very little if any advantage in efficiency is shown by the gas engine over that driven by steam, but if this statement is disputed, as I am not at all sure that it cannot be successfully, the burden of proof lies with the gas engine. At any rate for our purposes it will be proper to assume that the two are on a par as regards ultimate efficiency, and that so far as this is concerned the two types of engines may be interchanged in any installation which we may consider without affecting the result.

The gas engine has this practical advantage that it may be started and stopped when required, thereby avoiding the standby losses so fatal to economy where boilers are used. These standby losses for boilers are given by Dowson* as 10 per cent.; that is to say, that boilers that are standing idle and furnishing no steam will require 10 per cent. of the fuel they will take when working at their rated capacity. The gas plant, however, where gas storage is employed, has no standby losses of this kind, but, in many cases where fuel gas is manufactured to be used on the premises, adequate storage is not provided, and in times of light load part of the plant is banked. Under these conditions, Dowson states that the standby losses will not exceed 2·8 per cent. The advantages in favour of the gas engine in this respect, even under the most unfavourable circumstances, are therefore as 10 to 2·8 or 3.

As to fuel consumption in gas engines, foreign practice furnishes considerable data. Messrs. Crossley guarantee one brake horse-power-hour on a consumption of 1 lb. of anthracite coal, using Dowson gas. Under test conditions,† the gas engine plant at Chateau Say, supplying 650 lamps, consumed 1·2 lb. per indicated horse-power-hour. At Leven Tweed Mills, four gas engines, aggregating 200 horse-power, used in six days' trial 1¼ lbs. anthracite per brake horse-power-hour, or 1¾ lb. gas coke per brake horse-power-hour. At the Godalming mills gas engines, aggregating 400 indicated horse-power, averaged 1 lb. of fuel (character not stated) per indicated horse-power. At the Chelsea flour mill a 60 nominal horse-power, twin cylinder gas engine with Dowson gas, under full load test, used 0·87 lb. coal per indicated horse-power. But as we are all aware the fuel consumption under test conditions is no criterion to judge by, and especially misleading when we have under consideration an electric lighting plant. Furthermore, as I think has been conclusively shown, the fuel is by no means the only expense attending the production of power. Mr. Dowson places the cost of a Dowson gas plant of 80 horse-power at $20.31 per horse-power, and for a plant large enough to supply 530 horse-power, at $10.37 per horse-power. The wages of firemen for a gas plant are no more than for a steam plant, and a much cheaper fuel may be used. But let us assume that the fuel in both cases costs the same per ton, that the gas plant costs $20 instead of $10, so as to cover the cost of extra land required. Then our account would stand something like this :—

Cost of engines, 6·17 at $50	$308.50	
Cost of gas plant, 1·547 at $20	30.94	
Cost of buildings	120.00	
Cost of dynamos	120.00	
Total fixed investment	$579.44	
Interest on $579.44 at 4 per cent.	23.18	
Maintenance and depreciation of machinery, $459.44	34.06	
Buildings, $120, at 2 per cent.	2.40	
Total fixed annual cost		$59.64
Cost of coal, 2 lbs. for 8,760 hours, at $1.75	$15.33	
Cost of petty stores	1.64	
Cost of driving, stoking and cleaning	11.67	
		28.64
Total annual cost per electrical horse-power		$88.28
With coal at $3.50 the total cost		$103.61

Saving over present methods, with coal at $1.75 = $117.78 − $88.28 = $29.50; with coal at $3 50 = $148.40 − $103.61 = $44.79.

Thermal Storage.

Mr. Druitt Halpin, of England, has devised a method of thermal storage which has attracted wide attention abroad, and is likely to attract great attention in this country as soon as its efficiency becomes better understood. We all know that a boiler when supplying an intermittent demand is capable of supplying for a short time energy at a much more rapid rate than its steaming capacity would warrant; that during the period of light load it has stored up a certain amount of energy which it can give out again when called upon to do so. It will have been observed that during the period of comparative rest the pressure in the boiler will have increased, as also the temperature of the water and steam. It is this increase of temperature that constitutes the storage of energy, and with the same increase of temperature above the normal working temperature, the amount of energy stored will be proportional to the quantity of water heated. Since the quantity of water usually employed in our boilers is comparatively small, the storage of energy in them within the limits of safe pressure is, therefore, limited. Mr. Halpin, however, has conceived the plan of connecting the boilers to large iron storage tanks filled with water, which is brought to the same temperature and pressure as the boiler. It is a condition of any system of heat storage for central stations that the energy stored should be recoverable whenever and at any rate of supply required. Superheated water fulfils this condition, for if the pressure is reduced steam is generated instantly, and in controllable amount. This has given rise to three methods of procedure, which he has designated respectively "steam storage," "feed storage," and "combined feed and steam storage."

The first of these was very fully described by Prof. George Forbes at the St. Louis convention. The other two are later developments.

In the steam storage system Mr. Halpin employs only sufficient boilers to supply the mean demand and storage tanks sufficient to supply the maximum demand. These latter not being subjected to the fire will suffer but little deterioration, and being simple iron reservoirs of sufficient strength to withstand the pressures required are comparatively inexpensive to instal. The boilers working continuously at their most economical rate have their excess of energy during light load stored up in the water of the tank, from which it may be drawn at will during heavy load. He proposes that the boilers and tanks shall work under a pressure of 265 lbs. per square inch when fully charged, which corresponds to a temperature of 406° F. He proposes that the engines be worked at 130 lbs. per square inch, which corresponds to 347° F. The total available heat stored when the reservoirs are fully charged is the difference of the total heat of the water at 406° and at 347° F., or that due to a range of temperature of 59°. Every pound of water falling in temperature through that range will yield 61 thermal units of heat. The total heat required to generate a pound of steam at 130 lbs. per square inch from water at 347°, is 868·8 thermal units. Consequently 14¼ lbs. of water falling in temperature from 407° to 347° will yield 1 lb. of steam. To allow for radiation loss and imperfect working, this may be taken at 16 lbs. of water per pound of steam. The steam consumption per effective horse-power may be at 18 lbs. per hour in condensing, and 25 lbs. per hour in non-condensing

* "Gas Power," a paper by Emerson Dowson in the *Engineering Review*, November 30th and December 20th, 1894.

† Bryan Donkin, before Incorporated Institute of Gas Engineers.

engines. The storage room per effective horse-power by this method would, therefore, be $\frac{16 \times 18}{62{\cdot}5} = 4{\cdot}06$ cubic feet for condensing, and $\frac{16 \times 25}{62{\cdot}5} = 6{\cdot}4$ cubic feet for non-condensing engines.

Gas storage, assuming that illuminating gas is used, would require about 20 cubic feet of storage room per effective horse-power-hour stored, and if ordinary fuel gas were stored, it would require about four times this capacity.

In water storage 317 cubic feet would be required at an elevation of 100 feet to store 1 horse-power-hour, so that we see that of the three methods of storing energy, the thermal method is by far the most economical of space.

In the steam storage method the boiler is completely filled with water, and the storage tank nearly so. The two are in free communication by means of pipes, and a constant circulation of water is maintained between the two, but the steam for the engines is taken only from the top of the storage tank through a reducing valve.

In the feed storage system the excess of energy during light load is stored in the tanks as before, but the boilers are not completely filled. In this system the steam is taken exclusively from the boilers, the superheated water of the storage tanks being used during heavy load as feed water to the boilers.

The third method, as the name would imply, is a combination of these two. In the "combined" feed and steam storage system the pressure in boiler and storage tank is equalised by connecting the steam spaces in both by pipe, and the steam for the engines is, therefore, taken from both. In other words, they work in parallel.

An incidental advantage of thermal storage is the purity of the water supplied to the boilers. Since the latter derive their feed water from the hot reservoirs, it will have deposited its impurities where they can do no harm. The only unavoidable losses that need be considered in connection with thermal storage are those due to radiation from the reservoirs. This can be provided against by proper lagging, so as to be insignificant, and be still further reduced if there be a number of reservoirs. If, for instance, there are four, each will radiate from three-quarters of its surface towards the other three, and only from one-quarter of its surface into space.

(*To be continued.*)

REVIEW.

Electrical Boats and Navigation. By Thomas Commerford Martin and Joseph Sachs. New York: C. C. Shelley. London Agents: H. Alabaster, Gatehouse & Co., 22, Paternoster Row.

The contents of this volume will be found valuable and interesting to both builders and users of electrically-propelled craft, for, so far as we know, it is the only book of any pretensions devoted to the subject. No attempt has been made to give the details of every electric boat built up to date, but a certain number are dealt with as illustrative of the history of the art and of its evolution, and the work contains much data on the subject not hitherto brought together.

In the introductory and historical chapter we find an authentic but brief account of the experiments of Jacobi with his electric boat on the Neva, at St. Petersburg, in 1838, and those of other later experimenters with primary batteries, both in this country and abroad. Then the various devices of M. Trouvé are illustrated and described, including that absurd suggestion of a raft battery, in which the electrolyte employed is the sea-water itself, into which the electrodes dip and which are hauled along after the boat, to which they furnish the propelling power.

How an electrician of Mr. Martin's standing could have overlooked the error into which Trouvé fell is not for us to explain, but to say that a raft consisting of copper-zinc couples can be grouped so as to give the desired *voltage* and ampèrage is just on a par with the statement made by Dr. Herbert Tibbits that the Harness electropathic belt could be connected up for either intensity or quantity. Surely Mr. Martin must be aware that when all the elements are dipped into one electrolyte—the sea-water—the available E.M.F. can never be more than that of *one* couple? This nonsensical scheme might well be expunged from a second edition.

The next chapter is devoted to storage battery boats, and illustrated descriptions are given of the late Anthony Reckenzaun's *Volta*; the *Magnet*, the first storage battery launch put on American waters by the brothers Reckenzaun; two launches belonging to J. J. Astor, the electric gig built for the Grand Duke Alexander, and other boats.

A highly interesting third chapter on "Storage launch fleets and passenger boats" follows; and here the reader will find exhaustive data and estimates of cost for craft, charging stations and working operations, especially regarding the fifty-four launches which were in daily commission during the progress of the World's Columbian Exposition, held at Chicago in 1893. The money-making ability of this fleet ought to prove a great inducement for the rapid and profitable introduction of similar flotillas into this and many other countries; indeed, one cannot read the chapter without feeling that in this direction, at least, the use of electricity can be largely and lucratively extended by energetic and capable men. The fleet of the General Electric Power and Traction Company, Limited, with head-quarters at Platt's Eyot, Hampton, and also the four boats of the same company which were used on the Union Canal during the time of the Edinburgh International Exhibition in 1890, come in for special mention here.

The fourth chapter, which is brief, deals with the special features of storage launch operation and charging, and chapter five, equally short, is descriptive of special electrical craft, such as rowboats (where electrical energy may be used to supplement or diminish the labour of rowing), catamarans, paddle-wheel boats, &c.

Considerable space is then devoted to a lengthy account of submarine electric torpedo boats, including the diving boat of Lieut. Horgaard, Royal Danish Navy, Waddington's electric submarine boat, the well-known *Peral* of the Spanish Navy, the equally famous *Gymnote* made for the French Government, the *Goubet* submarine boat, said to be "provisionally" adopted by the Russian Navy, and the craft designed by Mr. Baker, of Chicago, which is not by any means the least interesting. These are all copiously illustrated, and to those interested in naval warfare, this chapter will be found specially serviceable. Then we come to a description of "dirigible electric torpedoes for warfare and life saving," where we find the Sims-Edison apparatus, already familiar to our readers, and devices of Nordenfelt and others, the chapter concluding with the *Victoria* torpedo of Mr. Read Murphy, the Australian. In the next chapter (VIII.) the authors deal with "Some General Considerations on Electric Launch Requirements," in which are two tables giving data of an interesting nature as to size, capacity, speed, cost, &c. The four succeeding chapters are devoted to canal boat propulsion, a subject we should think of some little importance here, in the face of the ruinous charges for freight made by the railway companies of England, and in some 50 pages the history of what has been accomplished in the States and on the Continent is very fully given, while the illustrations add considerably to the value of this portion of the volume.

Chapter XIII. deals with "Generating Plant and Distribution," and turbines, generators, motors, transformers, and conductors are in turn discussed, while Chapter XIV. takes into consideration the resistance of canal boats, and institutes comparisons between the propeller-*v.*-hauler methods of operating a large flotilla of barges. It appears that an electric system, whether propeller or hauler, can be economically employed, but lest our readers should be uncertain as to what the hauler system is, we may briefly explain that small electromotors supported by a light structure on the bank and running parallel to the canal, are each supposed to haul one or two barges, the regulation of the motors being effected from on board. Chapters XV. to the end take up the subjects of resistance of boats and propellers, paddle-wheels and screws, the miscellaneous uses of electrical power for boat propulsion and canals, storage batteries, motors and dynamotors.

To those enthusiasts who pin their faith to primary batteries as a simple, reliable, cheap (!) and efficient means of propelling pleasure launches, lighting houses, &c., the following extract will have some significance :—

"It should be pointed out here, for the benefit of those who have not before made a study of electricity, that a primary battery is one which when exhausted can only be replenished, refreshed, and renovated by a new supply of some of its constituents, such as the zinc or the solution in which the solid elements are immersed. These renewals are not only expensive—zinc, for example, being many times as costly as coal—but to effect them is generally a great nuisance and annoyance. To-day there are millions of such primary cells in use for telegraph, telephone, and other purposes, but the whole tendency of the times is to abolish and to substitute either storage battery current or current generated by means of a small dynamo or motor-generator. From this obvious state of facts it may fairly be inferred that where heavy currents are necessary, to drive motors for example, the primary cell is not likely to prove more desirable and efficient than in the departments where it is now less and less employed to furnish small currents for very light work."

With the views above it is scarcely necessary to say that we cordially agree, and we are glad to add that we feel the authors have in no way exaggerated the claims of electricity to boat propulsion, but have placed the situation fairly and honestly before their readers.

As we have already mentioned, the book is the only comprehensive work on the subject, and we cordially congratulate Messrs. Martin and Sachs on the compilation of a decidedly valuable addition to the literature of electrotechnics.

Elementary Lessons in Electricity and Magnetism. By Silvanus P. Thompson. New Edition. London: Macmillan & Co.

There is no modern elementary treatise on electricity and magnetism which we can more strongly recommend to the student than that of Professor Thompson. The first edition, issued in 1881, was excellent in its way, but the new edition is greatly superior to the first. Assuming the opening paragraph in the preface, viz., "The considerable changes made have been necessitated not only by the progress of the science, but by the piracy, covert as well as open, to which since its appearance in 1881 the book has been subjected," to be correct, it is a great compliment to the value of the book, albeit the writer must have been suffering acutely when he expressed himself so forcibly. There is everything to be said in favour of the new issue and very little to be said against it; the book has been thoroughly modernised both in matter and illustrations, for example, in the telegraphy section we find illustrations of apparatus exactly as they are met with in practice and not, as in the first edition, of a pattern which would make a practical telegraphist shudder to look at. In glancing through the book, we notice an unfortunate error on page 424 where a — sign has been inserted in an equation instead of a $\times$; the illustration, also, on page 417 does not represent the Post Office pattern bridge as it is stated to do, nor is it a fact that the sets of coils in a bridge usually include one of 10,000 so that a total of 20,000 can be made up, as stated on page 418. In some cases Professor Thompson appends a note against a method of testing, stating that it is unreliable; this might have been done with advantage in the case of the measurement of capacity test given on page 425 (commonly known as De Sauty's method), which is practically useless, for the reason that practical balance is obtained long before true balance is arrived at, and anything like even a fairly accurate result is consequently impossible.

In regard to the lightning conductor question, the author assumes a neutral attitude with reference to Professor Oliver Lodge's opinions on the subject; he says (page 320) "Professor Oliver Lodge maintains the lightning flash to be of the nature of an electric oscillation rather than a current. *If so*, the conductor of least resistance is not necessarily the best lightning rod." It is added "Professor Lodge and the author independently, *and for different reasons*, recommend iron in preference to copper for lightning rods. Extensive additions are noticeable in the form, descriptions and theories of dynamos. "The expansion of the science," says Prof. Thompson, "and of its practical applications, has rendered more difficult than before the task of presenting with sufficient clearness, yet with necessary brevity, an elementary exposition of the leading phenomena, and of their relations to one another." This is certainly the case, and the author has shown great skill in working under these conditions.

The Telegraphist's Guide to the New Examinations in Technical Telegraphy. By James Bell, A.I.E.E. London: *Electricity*, 29, Ludgate Hill, E.C.

This is an extremely useful little work, and should prove a most valuable help to members of the Postal Telegraph staff who aspire to promotion in the service. Formerly promotion in the commercial branch, *i.e.*, from the class of "telegraphists" to that of "clerks," and from the latter to that of "assistant superintendents" and "superintendents" was purely a matter of seniority supplemented by recommendation; within the last three years, however, such promotions have been also made contingent on the candidates showing that they possess a reasonable technical knowledge of their duties beyond mere superficial details. Such examinations appear to be altogether the correct thing, and must eventually result in the members of the staff carrying on their duties with more intelligence and consequent efficiency than at present. There is, doubtless, in many cases, considerable difficulty in telegraphists and others knowing where to obtain information on the subjects of which they are expected to know something, and Mr. Bell's book comes very opportunely. It is written exactly in the right style, and gives ample information on the "Why and wherefore" of technical details. To outsiders who may wish to know more about the arrangement of apparatus in the Department than text books are able to give, the work will also be valuable. Some useful questions are given at the end of the book.

The Cyanide Process for the Extraction of Gold. By M. Eissler. London: Crosby, Lockwood & Son, 1895.

The book just written by M. Eissler is a compilation on the cyanide process, which will be found useful by metallurgists and electro-metallurgists, who do not know in its details how gold is extracted from its ores. The volume is nicely got up, and contains 28 illustrations, showing tanks, precipitating boxes, views of the Worcester cyanide plant, &c.; but why is the portrait of Mr. Butters included? I should have expected to see a portrait of Messrs. MacArthur and Forrest.

The "Erection of a Cyanide Plant," "The Extraction by Cyanide," "The Siemens-Halske Process," "The Chemistry of the Cyanide Process," are the titles of the different chapters, almost all of which are reprints from the *Engineering and Mining Journal*, *Mineral Industry*, the *Mining Journal*, and other similar papers.

On p. 7, M. Eissler says that the fact that gold when in a fine state of division was soluble in cyanide of potassium solution was known in the middle ages, and the gilding of metals was carried out in those remote days by jewellers and alchemists, by the use of gold in cyanide solutions. To this, my reply is that cyanide of potassium was not known in the Middle Ages by the alchemists and jewellers, and that it was discovered by Scheele (see the last two pages of his *Chemical Essays*) where he called it "calx." I am sure M. Eissler cannot quote any authority to justify such a statement.

I cannot in a book on cyanide of potassium let pass such an error or misstatement as the following (page 40) on the discovery by Dr. Siemens of the use of cyanide as a solvent of gold. "In 1887, Dr. Siemens, the eminent electrician, of Berlin, found that the gold anodes, used in electroplating at his works, lost weight when standing in the cyanide liquor without any electric current passing through the bath." Dr. Siemens himself would not like to be called the discoverer of the solubility of gold in cyanide of potassium. It is a remarkable thing indeed that, in the case of the Cassel Gold Company, the most competent men of England in metallurgy, chemistry, and electro-metallurgy, gave their evidence before Justice Romer and mentioned Messrs. Elkington's process and their process of electroplating by means of a cyanide of gold solution, without saying a word of a standard book on electro-metallurgy by Smee, or of the Elkington specification. In his "Elements of Electro-

Metallurgy," Smee says:—"*Auro Cyanide of Potassium:* It is a salt somewhat analogous to the ferro-cyanate of potash, and is prepared in a variety of ways. It may be made by simply placing a piece of pure gold in a solution of cyanide of potassium, but this process requires some little time." It seems strange to me that Messrs. Elkington, or one of their family or firm, had not been asked to give evidence on their knowledge of cyanide of potassium as a solvent of gold, and I was unable to understand why these very competent men had not supplied some information as to a solvent of gold, which they, more than any one else, should know something about. I therefore read their specification, 8,447/1840, and found the following passage, which seems to explain the mystery of their absence in court during the cyanide law suit. "The third branch of our invention which consists as has been said, in coating, covering, or plating certain metals with gold by the use of a *solution of gold* simply in connection with the galvanic current, we perform as follows: We take oxide of gold prepared by any of the known methods, or *metallic gold in fine division*, and dissolve the same in a solution of prussiate of potash or soda. To about *2 ozs. of gold* converted into oxide, we add 2 lbs. of prussiate of potash dissolved in 1 gallon of water, and boil the same for about half an hour, and the solution is then ready for use. We prefer to keep the solution as nearly saturated with gold as possible, and for this purpose we keep a portion of oxide or of metallic gold in the solution undissolved. We claim, therefore, the method of coating, covering, or plating the metals above-mentioned with gold, by the use first of an oxide of gold or *metallic gold in fine division*, DISSOLVED *in prussiate of potash*, or any soluble prussiate."

If M. Eissler publishes a second edition of his book, he will, no doubt, give more particulars on the deposition of gold by zinc, and he will have, also, to describe more recent processes for extracting gold not only from tailings but from refractory ores by means of different and new cyanide solutions.

M. Eissler reprints in Chapter III. the paper by Mr. A. Van Gernet, which I have already criticised in the ELECTRICAL REVIEW, and in which he says that in the electrolysis of cyanide of potassium, a metalloid (!!) is liberated at the positive. I thought that as a chemist he would have corrected this error.

I call the author's attention to a few incorrect expressions, such as: "The *solution of water* in the zinc boxes is pumped into settling tanks" (page 29); "Argentine nitrate" (page 84), is a misprint; "Cyaniding concentrates" (page 34) is not a particularly happy neologism. The methods indicated for the determination of gold in cyanide of potassium are not the simplest and the best by a long way. Page 8, M. Eissler says that the application of this solvent for the treatment of auriferous ores was first thought of and patented in the United States in 1867; he refers, no doubt, to Rae, but he forgets to say that the Rae process was electrolytical. M. Eissler also omits to mention that the Cassel Company have lost their case in London, and that Justice Romer has decided that the case of "Cyanide of Potassium for Extracting Gold from its Ores" is public property.—E A.

ELECTROLYSIS OF GOLD (SOLUTIONS).

BY E. ANDREOLI.

FARADAY would have been horrified if he had been present at the lecture of the paper by Mr. N. S. Keith, at the Institution of Electrical Engineers, on "Electrolysis of Gold." Of course, this title means electrolysis of solutions of gold, nevertheless electricians ought not to speak loosely about electrical matters. His first sentence is remarkably strange as a definition:

"Obtaining the contents of gold from auriferous rocks and ores by means of solvents and subsequent precipitation is now attracting much attention in both scientific and financial circles."

The fact is that Mr. Keith says very little or nothing on electrolysis of gold solutions. With regard to his statement that the presence of oxygen is necessary for dissolving gold by a cyanide of potassium solution, there are some people ready to upset the elaborate equation he quotes, and his theories.

What Mr. Keith calls the electrolysis of gold is the electro-deposition of the gold solution formed by percolation of a weak cyanide of potassium solution through a mass of tailings.

Mr. Keith gives a description of the Siemens-Halske installation in the Transvaal, which has already been given and criticised in the ELECTRICAL REVIEW of November 9th, 1894, and finally he describes the following process, which he has patented in all the gold bearing countries, and which he says compares very favourably with the Siemens-Halske system:—

"Long boxes are provided, say a little over 2 feet deep and 2 feet wide, containing copper plates 24 inches square, and crossing the boxes every 1½ to 2 inches, but placed so that every alternate plate rests on the bottom and sides of the boxes, and the intermediate plates are raised about ½ inch above the bottom of the box.

"The number of plates and the length of the boxes are sufficient to permit of the deposition on them of all the metal constituents of the solution without so great a density of current that hydrogen is deposited likewise. If the solution be kept sufficiently in motion, the density may be 0·1 ampère per square foot of cathode surface .... These plates are preliminarily amalgamated with mercury, and are each connected with a 'bus-bar which is connected with the negative pole of the source of electricity.

"Between these cathodes are placed porous cells, filled with a half saturated or other strength aqueous solution of an ammonium salt, such as the chloride or sulphate. Into each cell is placed a rod, strip or prism of zinc or iron, and each of these is connected by wire to another 'bus-bar, which is connected with the positive pole of the source of electricity .... The cathode, though in its substance mainly of copper, is electrically a mercury one, therefore not as strongly electro positive in its electrolyte as is a copper one."

There is nothing particularly original in this mode of electro deposition, but although its merits and advantages are exaggerated, no doubt it is far superior to and cheaper than the Siemens process, which is neither very good nor new. But where is the electrolysis (of solutions) of gold? Nothing can be more disappointing than a play of "Hamlet" without the Prince of Denmark!

GAS v. STEAM ENGINES.

A CORRESPONDENT of the *Engineer*—A. Bollincks, of Brussels—takes up cudgels for the steam engine, and bases his remarks upon M. Witz's expressed opinion that engines using poor (*i.e.*, producer) gas are now near the limit of their economy. Taking a 300 H.P. engine, recently described, which consumes 2·27 metres of gas per horse-power hour at a cost of 1 centime per metre, he finds that 300 H.P. for 300 days of 24 hours each will cost 50,882 francs annually, with oil, waste, maintenance, &c. Then for the steam engine he takes an evaporation of 8½ kilos. per kilo. of coal, and the cost of coal at Brussels per 1,000 kilos. 13 9 francs. For 300 H.P. effective he takes an engine indicating 330 H.P., and using 5·46 kilos. of water, or, say, 12 lbs., and so arrives at an annual cost of 23,214 francs. But is Mr. Bollincks quite fair in taking the cost into consideration, should he not rather have quoted for us the weight and price of the fuel used per horse-power in the gas engine, and then have compared the results? For example, in Benier's gasogene engine, noticed briefly on February 22nd last, page 225, the fuel consumption was only ·752 kilo. of coke, while Mr. Bollincks's high-class engine uses ·642 kilos. of coal. Would the engine compete in price? It is doubtful. True, the steam engine may be improving daily; but is there not a far larger field for improvement of the gas engine? The abolition of the water jacket, if this could only be effected, would in itself place the gas engine at once far ahead of its rival. An internal combustion engine, whose initial temperature is the T_1 of the thermo-dynamic equation, cannot fail to stand a good final chance against an engine whose T_1 is derived from the indirect heating

processes of the steam engine. But it will be a long time before the steam engine is disestablished; it is the finest example of compromise in mechanical engineering, and though indirect in its heat transferences, is a most direct acting machine mechanically, and, above all, essentially controllable, easily started and stopped, and manageable in some forms by any labourer—hence its vitality. Returning for a moment, however, to the relative economy of producer gas engines and the best steam engines, we may recall the 300 H.P. engine to which we drew attention on December 7th, 1894. With that engine and producer plant M. Delamarre-Debouteville obtained 1 brake horse-power with ·468 kilo. of coal, or just over 1 lb. as against 1·41 lb. in the case of the very economical steam engine cited by M. Bollincky.

It would appear that 1 kilo. of coal will yield 4 to 5 cubic metres of gas. Now, a kilogramme of coal costs 1 centime when coal costs 10½ francs per ton, so that the fuel cost of 1 metre of producer gas is only 0·20 to 0·25 centimes, and in place of 50,882 francs annually as given, the cost of the gas engine horse-power would on the above basis come out as 11,656 to 14,118 francs, or from 50 to 66 per cent. of the cost of the steam horse-power. We would not ourselves lay any special stress upon any figures thus far obtained. The gas engine so far is but in a transitional period of existence, and is quite as likely to be improved as the steam engine.

DR. KEITH'S PAPER AT THE I.E.E.—AN ABORTIVE DISCUSSION.

By DESMOND G. FITZGERALD.

As a change from the engineering questions which have latterly been treated and discussed so fully before the Institution, many of its associates and students, I have reason to believe, looked forward with great interest to the reading and discussion upon Dr. Keith's paper. Not that they attached any great importance to the intrinsic merits of the latter, or to the particular views held by its author—a paper much open to objection, and therefore to discussion, is often a valuable contribution—the desire was to obtain some general knowledge of and some explanatory statements relative to a very important electro-metallurgical operation, which to most of us is not only a novelty, but in certain directions a somewhat puzzling and paradoxical novelty. The merits or demerits of the paper were in fact quite subsidiary to its value in promoting the "exchange of information and ideas amongst its members" which is one of the "chief objects" of the Institution. Dr. Keith's electro-chemical values, given almost at the outset of his paper, are at least open to question if not to objection; so much the better, provided the divergencies are discussed, for students whose note-books may require to be brought into accord and harmony with each other. Dr. Keith does not give any electro-chemical series showing the relations of conductors in an electrolyte of cyanide of potassium in very dilute solution; that does not matter provided some one else is allowed to do so, and thus to refute the claims made to the "discovery" that mercury is, under the given conditions, electro-negative to gold. Dr. Keith did not, in his paper, give his audience any notion of the potential differences obtained between conductors in the above-mentioned solution; although in the abortive discussion, and in answer to Mr. Swinburne, he was allowed, without contradiction, to state that "a zinc | gold couple decomposes H_2O and evolves O." Well, all this is of no detriment, but rather the contrary, provided the omission is remedied in the discussion. But in the contrary case, I may be allowed, as one of the oldest members of the Institution, to express the opinion that it would be more conducive to its interests not to accept any paper open to much criticism when no time can be allowed to estimate its merits and demerits, to point out its inaccuracies and shortcomings, to note any novel results and conclusions of value, and to exchange information and ideas on the subject.

I have glanced at some of the points on which information is generally required by the learner. With him, in his difficulties, we should sympathise, for we were learners once, and should be so still; and the learner of to-day may be the successful worker—the trustworthy authority—of to-morrow. Yet how frequently he attends the reading of a paper without obtaining any clue as to its real significance and practical value. Many of those to whom the art of cultivating a scientific reputation is always of paramount importance—to say nothing of those in whom the commercial instinct is still stronger—seem to consider it beneath their dignity (save the mark!) to aid in the lateral extension of science, to help the learner to overcome his difficulties, and to endeavour to make him as wise as—even at the risk of making him wiser than—themselves.

But perhaps the first question that would be propounded by the intelligent learner is this: Why should so poor a solvent—if it be a solvent—as a weak solution of cyanide of potassium (K C N or K Cy) ever be used, when so powerful a solvent as chlorine is so readily available? The simple explanation is that gold in chloride solutions is electro-negative to every metal, excepting those of the platinum group, and to a vast number of metallic compounds and organic substances; that minerals and soils containing gold in a state of minute sub-division frequently contain, in large proportion, compounds of metals electro-positive to gold in chloride solution; that by the effect of chlorine a *permanent* solution of gold is obtained only when all the metals present, which are electro-positive to it, have been fully acted upon by this solvent; whereas, in cyanide solution, gold is actually electro-positive to iron, antimony, tin and mercury, and cannot be said to be in all cases electro-negative to lead. Such an explanation, emphasised by a list of conductors in electro-chemical series, and by a few potential differences experimentally obtained, at once throws a flood of light on a matter which might have remained obscure, and allows the learner to discriminate between cases where a cyanide solution may advantageously be employed, and others in which the use of chlorine is indicated. At the same time it may give him some tolerably shrewd *primâ facie* views as to the metals adapted for use as depositing plates, or as soluble anodes when electrolysis is called into requisition.

Another question, of the greatest interest to the active-minded learner, is whether potassium cyanate (K C N O or K Cy O), and not potassium cyanide, is the real solvent of gold and of other metals. The author of the paper—as I managed to point out in the course of the abortive discussion upon it—deserves credit for pointing out, *incidentally*, but in quite unmistakable terms, that the cyanates are *not* solvents of gold. The contrary hypothesis—*si non e vero e ben trovato*—is a plausible one, and is not to be put down by any faint denial or disproof. It must be put down by other means; for it is a very dangerous hypothesis, leading to the mischievous use of oxidising agents, other than air, for the conversion of cyanide into cyanate. Dr. Keith points out that these agents have been termed (quite correctly I think) *cyanicides*; but he does not entirely condemn their use, though he somewhat enigmatically states that "they decompose more of the cyanide than is *necessary* for solvent action." I doubt very much whether it is necessary to convert any cyanide into cyanate in the adoption of means to promote the solvent action. Still the conversion is only too easily effected; nor is a further conversion long delayed, by which potassium cyanate splits up into potassium and ammonium carbonates, thus:—

$$2\,K\,C\,N\,O + 4\,H_2\,O = K_2\,C\,O_3 + (N\,H_4)_2\,C\,O_3.$$

Are any metals other than gold dissolved by a solution of potassium cyanide, and if so, what is the reaction? is another question that must be answered before the learner can get a good grip of his subject. And the answer is readily enough found in text-books. The solution dissolves metallic iron, zinc, nickel and copper, with evolution of hydrogen, whilst potash is produced:—

$$2\,K\,C\,N + Fe + 2\,H_2\,O = Fe\,(C\,N)_2 + 2\,K\,H\,O + H_2.$$

Well, but will not the solution dissolve gold in the same way? No, it will not; gold will not separate O from its combination with H_2. On the other hand it is quite certain that Au cannot separate C N (Cy) from K, except by the aid of some counterbalancing affinity. But when O is present, we have:—

$$2\,K\,Cy + 2\,Au + H_2\,O + O = 2\,Au\,Cy + 2\,K\,H\,O.$$

In the abortive discussion I managed, as above stated, to award a little deserved credit, in the cyanate matter, to the author of the paper, who—from the point of view, apparently, of a rival inventor—had been somewhat severely "slated" by Mr. Vautin. I also, in the interest of the numerous students present, to whom I knew it would be valuable, got in, edgeways, a brief quotation from Dr. Gore, viz., his "Order of the metals in a ·139 per cent. solution of K Cy, temp. 12·75 C.

+						
Mg	...	...	...	...	...	Ag
Zn	...	...	...	...	...	Sb
Al	...	...	...	...	...	Ni
Cu	...	...	...	...	...	Hg
Sn	...	...	...	...	...	Fe
Pb	...	...	...	...	...	Pt
Au	...	...	...	...	...	C."

At this point, however, our worthy president of the Institution, anxious to bring the discussion to an early close, and labouring apparently under the impression that the question of the solvent action of cyanates and the electro-chemical order of the metals in cyanide solutions have nothing to do, at least directly, with the subject of Dr. Keith's paper, intimated to me from the chair that I must confine myself to the subject in question. Now the ruling of a chairman is to me, as to all orderly Englishmen, a law which—during the period of the meeting at least—has only to be obeyed to the letter. I was to confine myself to "The Electrolysis of Gold." I saw at once that I had rambled away from this subject into the question of solutions of gold cyanide in potassium cyanide—a very different matter. I found, moreover, that I had nothing further to say; for the subject of the electrolysis of gold is one on which I am absolutely ignorant. Indeed, I have been under the impression that gold, if not an element, has at all events never yet been resolved into components—that it has not been analysed, and that, consequently, it cannot have been electrolysed. Somebody tells me here that I am taking the title of the paper too much *au pied de la lettre*. I beg to differ; the President and Council of the Institution of Electrical Engineers and Electricians would never have passed the title "Electrolysis of Gold" for "Electrolysis of Solutions of Cyanide of Gold in Cyanide of Potassium." Besides, the latter was the very subject I had been confining myself to. But here again I am told that I am wrong. There is, it appears, no "Institution of Electrical Engineers and Electricians" now. There is an "Institution of Electrical Engineers," but no "Institution of Electricians." Well, all I can say is that *there ought to be!* And here I must end the paragraph; for I am puzzled, and so, perhaps, may be some of my readers.

My right-hand neighbour at the "discussion"—whose name I did not catch—ventured to observe that he was by no means certain that cyanate solutions have no solvent action upon gold. I was pleased to observe that Mr. Swinburne at once communicated to him the necessary certitude on this point; it was a case of *experto crede*.

I will now give some data I was prevented from putting forward at the meeting. They are results of some experiments made under my supervision by my assistant, Mr. G. C. Alliogham.

In a ·1 per cent. solution of potassium cyanide, Au is electro-positive when opposed to the following conductors:—

−	P.D., volt.	
Pt	·16	
Hg (at first +)	·12	
Fe	·14	·17
Sn	·02	
C	·68	·74
Pb O_2 (lithanode)	·915	1·075

Gold would not normally, therefore, be deposited from the weak cyanide solution on any of the above conductors.

In the same solution, Au is electro-negative to the following metals:—

+	P.D., volt.	
Ag (sometimes −)	·01	·02
Pb	·13	
Cu	·16	
Al	·23 to ·735	
Zn	·635	·655
Mg	·95	·75

Gold would, therefore, to some extent be deposited from the solution upon these metals. In a 10 per cent. solution of potassium cyanide, the potential differences were as follow:—

−	P.D., volt.	
Pt	·31	·34
Fe	·31	·38
Hg	·10	
Sn	·16	·17
Pb (+ in dilute solution)	·08	·09
C	·69	·75
Pb O_2 (lithanode)	·965	
+		
Ag	·09	
Cu	·33	·42
Al	·79	
Zn	·71	·73
Mg	·34	·45

In regard to the electro-chemical equivalent adopted by Dr. Keith, I purpose making a note as to its divergence from the values usually adopted in this country.

ARGON: THE SUPPOSED NEW ELEMENT IN THE ATMOSPHERE.

III.

In reading the different communications called forth by the argon papers, one fact is most apparent, viz., that disbelief in the elementary nature of argon prevails far and wide among chemists, and that eminent physicists like Johnstone Stoney are by no means satisfied with the account of argon which its discoverers have rendered. The phrase, "While we are feeling about for what argon really is," which occurs in the paper published by that eminent physicist in the *Chemical News* of February 8th, indicates sufficiently that in his view the argon investigation has not passed through its initial phase.

A very amusing characteristic of these communications is that profuse laudation of the investigators of argon is usually accompanied by rejection of the conclusions arrived at by those investigators. Very amusing, for instance, are Dr. J. H. Gladstone's remarks in *Nature*, February 21st, wherein that gentleman relieves his mind by saying that "I will not attempt to weigh the respective merits of these lines of reasoning," "until we have some knowledge of the compounds of argon." "Trustworthy conclusions will not be possible till this further information is obtained."

Shocking, indeed, must the conception of argon appear to Dr. Gladstone when he realises that argon, so far as its discoverers know, has formed no compound, and can form no compound.

Returning from what has been written by others to the original publication by Rayleigh and Ramsay, and their associates, we have to note that too much importance appears to be attached to the spectroscopy of the subject. The history of the spectroscope, as an implement useful in chemical investigations, shows that, as a sign-post to lead the way, spectroscopy is invaluable. At the beginning of an investigation, it is specially so. Without its aid, cœsium and rubidium, and thallium, would have remained undiscovered up to the present day. But cœsium, rubidium and thallium, are now known quite apart from spectroscopy, and so it must be with argon, if argon is to stand its ground. Unless argon is able to dispense with the spectroscope, its fate will be that of jargonium, and we commend to the serious consideration of chemists the discrepancies pointed out by us in our former articles on this subject.

MECHANICAL POWER ON OUR TRAMWAYS.

By PHILIP DAWSON.

Mr. Hewson, Engineer to the City of Leeds, has lately presented to the Leeds Council a report, the tenor of which is decidedly in favour of overhead conductor electric tramways. Coming so soon after the decision of the Dublin and Bristol tramway companies to instal the same system, this report may be taken to show that the electric "trolley car"

is not so wholly unsuited to English conditions as its opponents would lead us to imagine.

For several years past we have heard of the American system of elevated conductors, but have had no opportunity to test its adaptability through large installations within easy reach. The comparatively recent introduction of electrical motive power in Havre, Bordeaux, Lyons, Brussels, &c., close at hand, have enabled our engineers and tramway owners and inventors to thoroughly examine and determine the merits and demerits of the system by personal inspection under conditions not greatly dissimilar to those which here maintain.

It would seem that at the present day but two systems of mechanical traction show any demonstrated financial success. These are the cable and the electric elevated conductor. They do not compete, as each has its appropriate place. For extremely heavy traffic in broad and straight thoroughfares, or where very heavy gradients are met with the cable has no rival. But for the average English tramway having a fairly long mileage and a moderate traffic, the overhead electric system is the only one possible. The use of the cable in such a case would certainly mean financial disaster. Not only is the capital investment necessary to instal a cable system far heavier than that required for the elevated electrical trolley system, but the working expenses are also greater until the headway on which the cars are running becomes sufficiently small and the traffic sufficiently heavy.

According to Mr. R. J. McCarthy, general manager of the Metropolitan Street Railway Company of Kansas City, Mo. (operating horse, cable, and electric lines), the cable becomes superior to the electric system as regards working expenses, when the headway on which the cars are running is less than one minute, the cable running at ten miles an hour.

The injudicious installation of cable lines has more than once led to financial disaster in America. In Minneapolis, St. Paul, Denver, and other American cities, cable equipments have been abandoned and overhead trolley lines have taken their place, with distinctly favourable financial results.

Mr. Higgins in his "Street Railway Investments," mentions a town of 100,000 inhabitants where a bankrupt cable road was transformed, together with certain horse tramways, into a trolley line, and, although in this instance the capital investment amounted to some £18,000 per mile of track, the result was that earnings became equivalent to 4·3 per cent. on the accumulated liabilities. This line is now worked at 5½d. per car mile, and at 64 per cent. of the passenger income.

Table I. is interesting as showing the results obtained under the same management by cable and electric roads in the same city. The results given disprove an impression which seems to exist generally that the working expenses of a cable road are always inferior to those of an electric line. They also show the sort of traffic necessary to make a cable road a paying concern.

It is undoubted that in cities like Chicago and New York, for such thoroughfares as Wabash Avenue and Broadway, where cars follow each other at intervals of 15 seconds or less, the cable is the only thoroughly commendable system.

No possibility of such traffic can be expected at Leeds, and in the absence of such expectations there is nothing to warrant the expenditure of capital which would be entailed by the cable. Mr. Hewson has ably set forth the comparison of the two available systems in his report to the Leeds Council.

There seems to be another point worthy of some consideration and which was brought forward by a committee of the American Street Railway Association, appointed in 1893 to report on the relative cost of operation of horse, cable and electric roads. They say:—"We believe that cable road practice has reached the stage where but little room is left for improvement. They have been developed, improved and operated by the best engineering skill which the country affords. Nearly all are on a good dividend paying basis; but whatever the past experience of the two systems has been, or whatever the present status of the two may be, we are only voicing the convictions of well informed engineers when we say that electric systems will continue to increase in efficiency (by which is meant earning capacity) until all rivals are distanced and only one method of rapid transit is recognised—the electric car." That this is the case is clearly shown by Table II.

In a previous article we have already given in detail the working expenses of the Roundhay electric tramway. We give now, Table III., the working expenses of two well-managed American electric tramways for last year. We think it certain that with the cheaper English labour, the total operating expenses, when all the Leeds tramways are converted to the trolley, will not exceed 5d. per car mile.

The report of the Leeds City Engineer has been contrasted with that of Mr. W. Geo. Laws, handed in to the Newcastle Corporation, and which was all in favour of the cable. It must be borne in mind, however, that this report does not consider the overhead trolley system, and that the comparison instituted was only between horse, the electric conduit, and the cable system. This is expressly stated by Mr. Laws at the commencement of his report, and we think it more than probable that had this gentleman been allowed to report on the trolley system as well, the conclusions he arrived at would have been very similar to those set forth by Mr. Hewson.

It may be taken that so far there is no reason to consider an electric conduit line to have any advantage over a cable plant. The probability is distinctly the reverse.

In America the public prefer electric to cable cars for their easier riding, better lighting, and higher speeds.

Mr. Higgins, in speaking of a town of some 300,000 inhabitants, says of this:—"It is worthy of note that, on certain important through lines in this city, electric and cable roads parallel each other about two blocks apart, and the electric lines are so much more popular than the cable that there is a serious thought of converting the latter to electricity."

Mr. Higgins is in no way an electrical enthusiast. He looks only at the financial side, having no interest in any particular system.

All the electric roads on the Continent which we know of have turned out financial successes. In most cases they are working at from one-third to half of what they did when they were run by horses.

Table I.—Comparison of Cable and Electric Systems.

Citizens Traction Company of Pittsburg, Pa., 1894.

	Cable.	Electric.
Transportation per car mile	2·86d.	2·32d.
Power per car mile	0·49d.	0·67d.
Maintenance of way per car mile ...	0·63d.	0·50d.
Maintenance of equipment per car mile	1·89d.	0·73d.
General expenses per car mile	1·05d.	1·27d.
Total operating expenses per car mile	6·92d.	5·51d.
Ratio of operating expenses to receipts	48·73%	73·87%
Length of track	12 miles.	12 miles.
Number of cars	68	20
Car miles run	1,838,915	589,321
Passengers carried	11,539,649	2,365,968
Cost of H.P. per hour	1·97d.	1·92d.

Table II.—Showing Increase of Profit by the Introduction of Electricity.

	Binghampton R. R. Co., N.Y.			Buffalo Street Railway Company.		Columbus, Ohio.	
	1892.	1893.	1894.	1893.	1894.	1893.	1894.
Gross earnings	£13,650	£20,671	£24,494	£296,450	£303,286	£106,881	£113,076
Nett earnings	5,167	8,238	10,695	28,669	42,322	40,948	59,716
Ratio of operating expenses to receipts ..	59%	57½%	57%	61·1%	55·8%	62·5%	47·8%

Table III.—Showing Operating Expenses of Two Electric Tramways during 1894.

	Reading, Pa.	Columbus, Ohio.
Transportation per car mile	2·28d.	2·32d.
Power per car mile	1·75d.	0·44d.
Maintenance of way per car mile ...	0·13d.	0·29d.
Maintenance of equipment per car mile	0·35d.	0·39d.
General expenses per car mile ...	0·98d.	0·69d.
Total operating expenses per car mile	5·49d.	4·13d.
Ratio of operating expenses to receipts	58 per cent.	47·8 per cent.
Length of track...	35 miles	55 miles
Number of motor cars	87	142
Car miles run	991,071	3,226,746
Passengers carried	4,955,355	12,676,018

DISTRIBUTION OF ENERGY IN THE SPECTRUM OF THE GLOW LAMP.

The *Physical Review* publishes an interesting paper by Dr. E. L. Nichols, in which the author discusses the emissive properties of black and bright carbon filaments. The work of certain earlier observers on this subject, to wit, Mortimer Evans, H. S. Weber, and J. C. Shedd, is first noticed, and the author then proceeds to describe some carefully conducted spectroscopic experiments he carried out with Mr. E. F. Nichols with the object of ascertaining the amount of radiant energy distributed between ·8 μ and 3 μ of the infra red range of the spectrum.

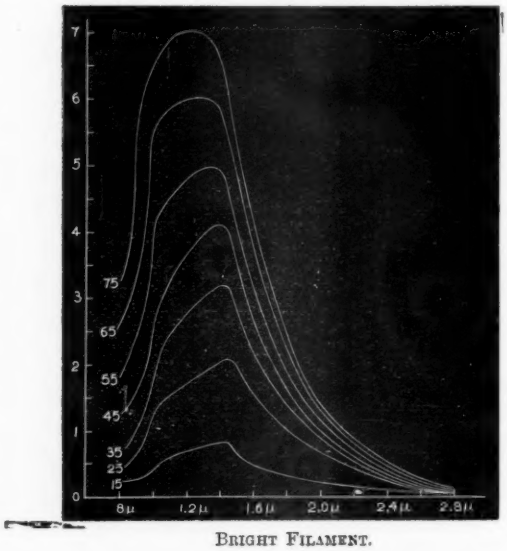
Mr. Evans in his paper, read at the Royal Society in 1886, came to the conclusion that the proportion of light rays to those of non-luminous rays was much larger from a filament possessing a bright metallic looking surface than was the case from one having a black surface. Without in any way denying that the advantage may be in favour of the brighter filament, we think, as Dr. Nichols gently hints, that Mr. Evans did not sufficiently consider the change which occurs in the extent of radiating surface when filaments are flashed and treated in different ways, and that, as a consequence, his conclusions are not very reliable. Prof. Weber determined the coefficient of the radiating power of 33 varieties of glow lamps, and found it to lie between 0·0000169 and 0·0000174 for the black descriptions of filaments, whilst for the brighter kinds it was between 0·0000127 and 0·0000132.

Mr. Shedd studied the subject from a spectroscopic point of view, and published his results in 1892.* In the main, he found them confirmatory of the higher efficiency of bright carbons, but he noticed that other factors, notably that of degree of vacua, largely affected the relationship between the energy expended in the lamp and the candle-power. His observations relative to the light emitted by gas flames and that from lamps containing treated and untreated filaments are summarised as follows:—

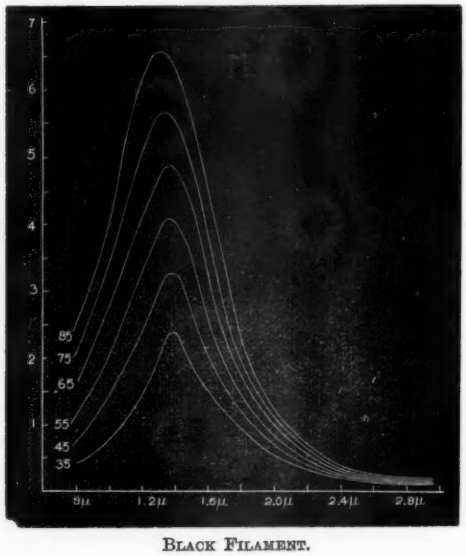
"1. Spectro-photometric measurements with lamps of untreated filaments of vegetable fibre showed that the light was of the same colour as that from gas (in the Argand burner), when the lamp was being operated at an efficiency of 6·8 watts per candle. All efficiencies lower than this showed relatively higher intensities in the red, while all efficiencies above 6·8 showed a light which was bluer than that of gas. The relative intensities of wave lengths in the light emanating from such filaments were found to vary quite rapidly as the incandescence rose. Such a lamp, for which the ratio $\frac{\text{glow lamp}}{\text{gas flame}}$ for the region of the D line was unity, gave for wave length 0·4 μ, about 1·6.

"2. In the case of treated filaments with bright surface, on the other hand, equality with gas light as regards whiteness was reached only at somewhat higher efficiencies, viz., between 4 and 6 watts per candle. The changes in the colour of the light from such lamps appeared, moreover, to be much less marked than in the case of filaments with black surface. The variation in quality, indeed, was frequently scarcely noticeable when the lamp was brought up from 7 to 4 watts per candle. It would appear from Mr. Shedd's measurements, that in the case of black filaments the increase in the intensity of short wave lengths with temperature was much more rapid than in the case of the longer wave lengths; whereas with bright filaments all the wave lengths of the visible spectrum gained in intensity at very nearly the same rate."

To overcome the difficulty of difference in vacua, Dr. Nichols had two lamps made in permanent communication with one another by means of a glass connecting tube. Both filaments were of the same description, and both were flashed in hydro-carbon vapour. One was subsequently "smoked," the other was left bright. When exhausted the two lamps were very different in voltage, owing to the blackened filament presenting a much larger radiating surface. As the lamps could not be compared by the mere determination of the candle-power and the watts per candle, the investigator subjected them to detailed measurements as regards the distribution of energy in the infra-red spectrum through a wide range of temperature. The apparatus and method of working are described at considerable length in the paper, which should be consulted by those specially interested. In brief, the apparatus consisted of a spectrometer, into the eye-piece of which was inserted a linear thermopile, dispersion being obtained by means of a prism of carbon bisulphide. The corrected results obtained with the respective lamps are given in the two following figures:—



Bright Filament.



Black Filament.

The paper concludes with the following remarks:—"It will be seen that the distribution is very different in the two cases, the maximum in the case of the latter being nearer the visible spectrum. Were both sets of curves extended to the shorter wave-lengths, it would unquestionably be found that the area of the portions lying within the range of the luminous rays is larger in the case of bright filaments, a result which would afford a complete explanation of the superiority of such filaments in the production of light, as shown by Evans in the experiments already described.

"Similar measurements to the above were made upon a commercial lamp with untreated filament bamboo. The lamp in question is the one used as a reference light in the experiments of E. F. Nichols upon absorption in the infra-red.* It will be seen, by reference to his curves, that the distribution in the spectrum of this lamp was in every respect similar to that in the spectrum of lamp 1$_b$.

"The complete investigation of the problem with which this present paper deals would involve the direct measure-

* Thesis: in Library of Cornell University.

* E. F. Nichols, *l. c.*

ment of the temperatures of the radiating surface. In such an investigation, to which the experiments here described are preliminary, the writer is now engaged. The results are to be given in a subsequent article."

CORRESPONDENCE.

The Niagara Dynamos.

My letters in your columns on this subject were in answer to your statement that Mr. C. E. L. Brown had made dynamos with external revolving fields. In your last issue he expressly disclaims this, and the Patin alternator to which he refers has a stationary armature between two revolving fields, thus failing entirely to secure the advantages I sought after—namely, mechanical strength to resist centrifugal force; magnetic pull in opposition to centrifugal force; and maximum momentum with minimum weight.

These advantages are not appreciated by the writer of your leaderette of March 8th, and when you there say that "downward pressing weight was necessary on the shaft of the turbines at Niagara, therefore an external armature has an advantage there," and, further, proceed with equally irrelevant remarks, I regret extremely that it becomes impossible to make use of your columns for further discussion. I beg, however, to say that most of the points mentioned by Mr. Brown, whether novel or not, are not adopted in the Niagara dynamos.

George Forbes.

[We are sorry that Prof. Forbes regrets the impossibility of making further use of our columns in this matter. We did not discuss the *advantages* he sought for, so we must pin him to the paragraph in Mr. Brown's letter commencing "It is quite true that Prof. Forbes," &c., &c.—Eds. Elec. Rev.]

Electrical Currents in the Living Body.

The interesting lecture by Prof. Horsley on the subject indicated above, and reported in your issue of the 1st instant, though embracing a recapitulation of some valuable researches upon the question, seems to be hardly up to date, and I had hoped some more able pen than mine amongst your many interested readers would have written you of the important experiments, with their results, of Drs. Bleyer and Weill, described in a paper read before the American Electro-therapeutic Association, in September, 1893, entitled the "Primary Action of the Galvanic Current," and duly reported in your estimable columns. However, I will here, with your kind permission, give a brief outline of that paper, and the deductions that may be inferred therefrom. Drs. Bleyer and Weill commence (after giving some particulars of the character of ozone), by relating the long-standing *suspicions* that ozone exists in the normal blood, until Kühne and Schmitt in 1865 *proved* that ozone existed in the blood in readily appreciable quantity. Drs. Bleyer and Weill state that, "their experiments with the galvanic current are in a line with those of Kühne and Schmitt, only a short step in advance." They then quote accepted physiological facts as to the process of oxidisation in the metabolism of the tissues of the body and say, "our observations point to one conclusion, that chemical action, the feeder of life, *cannot* go on unless there is present an electrical force," and consequently assume that the "animal electricity" (now fully recognised), is the source or factor of the ozone present in the living body, and say "there is but one possible action of ozone (or condensed oxygen) on the blood, it must hurry on the transfer of the oxygen to the tissues, call into existence the oxidisation of those constructive elements which the tissues require for their revivification. Doubtless these changes are more extensive than we have been able to determine." Drs. Bleyer and Weill then give complete details of their delicate and carefully conducted experiments upon rabbits, firstly, undoubtedly observing ozone in the normal blood (defibrinated), then passing a current of 15 ma.'s at 10 volts through the diluted fluid for a few minutes with the result that it was agreed between the experimentalists and a third spectator (Dr. Dittrich), that the increase of ozone after the passage of the continuous current amounted to "*at least two and a half times greater* than the amount indicated by the reaction in the case of the unelectrified blood." They then report experiments upon an electrified animal itself, cutting the skin in two places and passing a current of 44 ma.'s at 20 volts for a few minutes when the defibrinated blood (from the carotid arteries) gave almost immediate ozone reaction, which was estimated to be *three times greater* than that which gave reaction from the normal blood. It is well known among electro-therapeutists that electrification, under certain conditions, induces the body to excrete a greater amount of carbonic acid and urea; what is the significance of this, other than "increased tissue metamorphosis?" "Whatever value the results we (Drs. B. and W.) have obtained may have, there can be no doubt that the galvanic current applied to the living body, whatever else its action may be, increases the amount of ozone both in the corpuscle and in the plasma." If this be the case, and there appears no reason to doubt it, does it not account for the "utility" of the "animal electricity," in polarising the neutral oxygen in the system, converting it into ozone, thereby hastening the highest of physiological processes, and which the primary action of the passage of a continuous current, at least, *trebly* augments. The detailed account of these valuable experiments are reported in the Electrical Review of November 17th and 24th, and December 1st, 1893, and should be read by all interested. The interrupted coil or faradic current is employed largely as a stimulant to the function of both nerve and muscle, and its physical or mechanical action is indeed a powerful factor. Probably the primary action of the faradic current in medical application is in promoting healthy muscular contraction, thereby pressing out the venous blood and waste products of tissue change, making way again for fresh arterial supply, producing increased nutrition, now well known. In the circulatory system I regard the muscles of the body as so many *auxiliary hearts* voluntarily controlled. Permit me just a word *re* quackery and empiricism bearing upon the subject. Deplorable as electro-medical quackery is, I would ask, how does it compare (in quantity at any rate) with the stupendous amount of advertised drug-treatment, defacing the pages of our daily and other papers? And righteously honoured and respected as is medical practice generally, I am forced to believe it is no more exempt from a measure of (perhaps necessary) empiricism and arbitrariness than is attributed by Professor Horsley to this particular branch of *bonâ fide* electro-medical treatment, especially as Dr. Hedley shows in his able and interesting letter in your last issue with regard to many popular Pharmacopœian drugs.

Arthur C. Hattatt.

March 15th, 1895.

St. Pancras Explosions.

Referring to your interesting article of the 8th inst. on the cause of the St. Pancras explosions, I see you make a statement to the effect that the hydrogen produced by the action of water and sodium will take fire "under certain artificial conditions." What these conditions are you do not state, but from other remarks in your article it may fairly be concluded that you do not think they would be present in the St. Pancras conduits.

May I recommend you the following simple experiments:

1. Take a small piece of sodium and put it in a basin of cold water. It runs about on the surface with a hissing noise, and the escaping hydrogen does not take fire.

2. Now put a piece of wet blotting paper on the surface of the water, and put the sodium on the blotting paper, when you will find that the escaping hydrogen takes fire.

3. Put a piece of sodium in a dry place, and drop a little cold water on it, and you will find that the escaping hydrogen takes fire.

4. Put a piece of sodium in a bowl of hot water, and the hydrogen again takes fire.

My excuse for referring to these experiences of childhood is that they throw a light on the St. Pancras case somewhat different to that of your article. They seem to me to show that the energy with which sodium decomposes water produces heat at a rate sufficient to cause the ignition of the escaping hydrogen, unless by darting about in a good supply of cold water, a sufficiently rapid cooling action takes place.

If you will consider the various ways in which, if sodium were present in the conduits water might come in contact with it, I think you will agree with me that only in the case of a flooded conduit would the cooling action be sufficient to prevent the ignition of the escaping hydrogen.

A. A. Voysey.

City Sewers Electrical Laboratory,
Wool Exchange, Basinghall St., E.C.,
March 19th, 1895.

[The City electric light inspector is good enough to endorse our statement that under certain artificial conditions the hydrogen produced by the inter-action of water and sodium will take fire, and since we did not define these conditions, he is kind enough to name some under which the phenomenon of inflammation is evinced. With these, and some others which Mr. Voysey has not mentioned, we are, of course, already acquainted. But Mr. Voysey will surely agree with us in claiming that none of the conditions which he specifies, may reasonably be expected to be present in an electric lighting conduit. We do not anticipate the presence of "a piece of wet blotting paper," nor of a "bowl of hot water" in either conduits or boxes. And bearing in mind the hygroscopic qualities of the atmosphere and of the brickwork, and the normal appearance of the surfaces of these conduits and boxes, we cannot presume that he will be disposed to disagree with us in assuming that neither of these *loci* can, by any stretch of the imagination, be considered to be "a dry place." Lucidity of expression is, without doubt, a great and difficult art, and we can scarcely complain if all our critics have not succeeded in understanding us; but, even if the deliberations of the Board of Trade, in conjunction with the commissioners appointed by the Institution of Electrical Engineers and the Royal Society, *do* result in the finding that metallic sodium, or some alloy or compound of the substance, is the proximate cause of the St. Pancras explosions, it will be clear to all, who have intelligently appreciated the position we have taken up, that we shall not be "left," as our American contemporaries would express it.—Eds. Elec. Rev.]

An Oft-Repeated Story.

Is the game worth the candle? I spend time and money in preparing estimates for electrical work, and, after all, am told that Messrs. So-and-So, the well-known ironmongers or plumbers, or, as in your last week's issue, tailors, have been successful with an estimate of about £200 below mine in a £500 job. Now, if mine was a fair estimate, *what* is theirs? Have these firms a magic wand for creating material out of nothing, or are they running a charitable institution? If a certain firm not 1,000 miles away from Leeds *is* making money out of their electrical department, I should be glad of the addresses of the firms they buy their material from, as they certainly take work 30 per cent. cheaper than anyone else in the district, and I and others fondly imagine we buy in the cheapest market. The man (the consulting engineer) who ought to stop this unfair competition, how often does he fail in his mission, as he cheerfully gives the order to the lowest tender, no matter what it is, at the same time knowing that the fair price is, in some cases, 30 per cent. above. Surely there is some way of checking this unfair competition, which is a feature of no other trade but the electrical trade, and is fast causing it to degenerate. Perhaps some other contractor will give us his views on the subject, as fair trading is anxiously looked forward to by

Contractor.

[This subject has often been commented upon in our columns. The electrical trade is, however, not the only industry suffering from the evil. The peculiar circumstances of electric wiring leave the arrangement of a standard of prices out of the question. The whole matter must be left to the fairness of tenderers. They cannot fail to observe, sooner or later, the disastrous effect, both to themselves and others, of the more or less short-lived and suicidal policy of undercutting.—Eds. Elec. Rev.]

The Compiling of Catalogues.

Kindly note that the balances illustrated in Messrs. Elliott Bros.' catalogue of January 1st, 1895, are those made by me, though, by inadvertence, Messrs. Elliott Bros.' name appears on the illustrations instead of mine.

Messrs. Elliott Bros. have most courteously undertaken to call attention to this mistake in the copies of the catalogue still in their possession.

L. Oertling.

The Discussion on Mr. Sayers's Paper.

My attention has been called to a slight error in the Electrical Review of March 8th, page 304. The formula I proposed at the Institution of Electrical Engineers for the distribution of magnetism in the air gap in the case of projection armatures is $2 \text{K M C} = l\,d + \left(\text{A} + \frac{d}{k}\right) f_1\, l_1 - (\text{A})\, f_2\, l_1$.

If you will be good enough to reprint this in corrected form, I shall be exceedingly obliged.

H. F. Parshall.

Practical Works on "Alternating Currents."

I should esteem it as a great favour if you would kindly give me the benefit of your advice in choosing one or two practical works on alternating currents, embracing as many of the following headings as possible:—

Transformer construction and testing.

Constructional description of modern alternators and multiphase generators.

Methods of finding inductance in circuits by ordinary arithmetic, also the effect upon phase of a given condenser upon given circuit, &c.

Instance of successful use of condensers.

Alternating and multiphase motors, methods of starting.

A. H. G.

[1. "Alternating Current Transformers," by Weeks, and Prof. Fleming's; Vol. ii. of the "Alternating Current Transformer."

2. There is no work published on the construction of modern alternators and multiphase generators. Kapp's works are the only ones touching on the subject.

3. Fleming's and Weeks's books.

4. No books on this subject, but instances may be found in the Electrical Review and contemporaries.

5. Electrical Review and contemporaries; Snell's "Electromotive Power."—Eds. Elec. Rev.]

THE DISINTEGRATION OF ORGANIC TISSUE BY HIGH TENSION CURRENTS.

At a meeting of the Obstetrical Society of London, held on March 6th, Dr. J. Inglis Parsons read a paper, an abstract of which we take from the *Lancet*, on the "Disintegration of Organic Tissue by High Tension Currents." He said that these investigations were undertaken to ascertain the capabilities of electricity as a destructive agent in the treatment of malignant disease. He had found from former investigations that the constant current was only effective at the poles for this purpose even with powerful currents. By using powerful interrupted voltaic currents a much greater area was injured, apparently by the force of the impact. He had some success with this method, but the results varied, some cases being more resistant than others. If the strength of the voltaic current was raised to meet this too much heat and caustic action were developed. Having noticed the disruptive effects produced by currents of high electromotive force, it was decided to have a transformer made to a special design. By this means quantity was turned into pressure, heat and caustic action were reduced to insignificance, while the destructive action was enormously increased. The transformer was capable of working up to 150,000 volts, and could be graduated from zero to the pressure required within certain limits. The resistance of the transformer was kept low, so that as large a proportion of energy as possible might be expended on the organic tissue when in short circuit. The primary coil was supplied by six accumulators. A manual rheotome was used so that the operator had perfect control over his instrument. Freshly-killed beef was chosen as the best organic tissue upon which to try the discharges, because

its structure would easily show any alterations that might take place, and it could be obtained in sufficient mass to allow the current to diffuse. Great difficulty was experienced in cutting sections from the beef after the current had passed through it. Even when frozen or mounted in paraffin it crumbled away into *débris*. By lowering the pressure in the transformer some sections were obtained and the muscular fibres were found to be broken up throughout the path of the current. The destruction was found to extend throughout the path of the current, and was not confined to the poles like the constant current. The sections showed no evidence of heat or caustic action. Some experiments were then tried with an air gap in the circuit, instead of connecting the beef directly to the transformer. The destruction was nothing like so great, probably on account of the high resistance of the air gap. The diffusion of the current was then worked out as nearly as possible by cutting sections from different parts of a thick piece of beef after the passage of the electricity. The area broken up was found to correspond very nearly to the shape of an elliptic spindle. When the poles were not always placed at the same distance apart, it was necessary to know the proportion between solid elliptic spindles of different sizes. With the pole 6 inches apart, the solid contents were 27 times greater than at 2 inches, consequently a corresponding increase or decrease must be made in the pressure of the current, or the number of interruptions, according as the needle points were moved further apart or brought nearer together. Finally, a Leyden jar, acting as a condenser, was then introduced into the circuit. The character of the discharge was altered. It took place with far greater rapidity. The maximum pressure was lowered to about 20,000 volts, with a corresponding increase in quantity. The sections taken showed an utter destruction of the beef. Apparently very little diffusion occurred; the discharge made only a narrow lane from one pole to the other.

Dr. Lewis Jones said that he had made similar experiments on the disintegration of tissue by means of high tension discharges, using a transformer. He was astonished that Dr. Parsons should speak of the destruction of tissue as being produced by the "force of impact," such an expression being vague and meaningless. The destruction of the flesh was due simply to the heat produced by the discharge; indeed, there was no other possible way in which the electrical energy could expend itself on such a conductor as a piece of flesh. In his (Dr. Lewis Jones's) experiments, the piece of meat quickly became heated, and if the operation was continued it soon emitted steam and smoke, and finally flame. To say that there was no heat because a thin platinum wire was not heated by the coil discharge was most misleading. Of course, under the conditions of the experiment shown, the platinum wire could not possibly have been heated appreciably. The destruction of tissue was much greater round the poles than in the interpolar area, and this point should have been mentioned more clearly by Dr. Parsons.

Dr. Horrocks said that if it could be shown that living cells, either normal or pathogenic, could be broken up by an electric current, then it was conceivable that this method had a future before it. If one could break up the tissue of, say, a tumour or an inflammatory mass by electrical currents, one might succeed in setting up changes which would result in the absorption of the tumour or the exudation. He could not quite understand how Dr. Parsons had arrived at the conclusion that none of the effects produced were the result of heat. Certainly the sparks shown that evening were very much like lightning flashes, and it was a well known observation that in death from lightning there was evidence of the effect of heat, especially at the entrance and exit of the electrical fluid.

SULLIVAN'S UNIVERSAL GALVANOMETER.

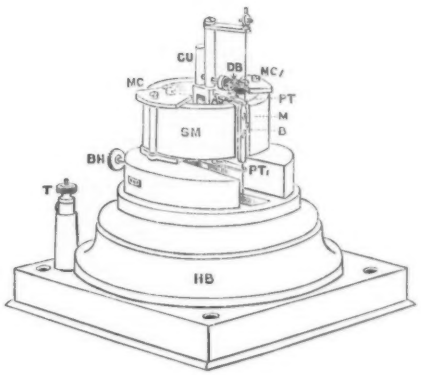
This is the only form of moving coil galvanometer which can be used at sea, and the only one which alike answers every testing and speaking requirement. Its sensibility is high and variable within wide limits, and it can be damped at will to absolute deadbeatness. It is alike adapted for testing or receiving messages through any length of cable or non-inductive line, down to one mile—a point of convenience more especially on board cable repairing ships.

The magnet is C-shaped, with a narrow coreless coil covered with a copper shield, and having a very small moment of inertia. The suspension frame carrying the coil system is interchangeable. A sleeve, or tube, at its back, fits over a cylindrical upright planted upon a sliding base plate, this base plate being movable forward and backward by means of a brass head projecting behind through the cover of the instrument. Thus by pushing or pulling the brass head, the position of the coil in the magnetic field, and, consequently, the sensibility of the instrument, may be varied without removing the cover.

The coil is suspended above and below, the upper torsion head being in metallic connection with the suspension frame, whilst the lower torsion head is insulated therefrom with vulcanite. The current is led to and from the coil through the suspension wires, which are in permanent connection through their torsion heads with two insulated platinum studs on the lower arm of the suspension frame. These insulated studs are so placed that when the frame is pushed down into position they press upon two independent springs fixed in the hollow base of the instrument, and in permanent connection with the terminals. This dispenses with outside wire connections and allows the suspension frame to be rapidly changed when necessary.

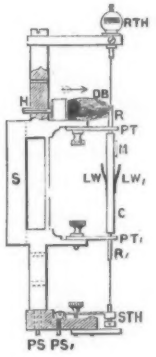
The coil ends are soldered to the rigid rods projecting from it, and in order to prevent the coil from falling out and sustaining damage in case of breakage of the suspension, the frame is provided with two adjustable tongues, pierced at their ends with apertures through which these rods pass without touching. It will be seen that should the suspension break the lower tongue takes the weight of the coil, thus holding it in position.

The trouble experienced with former galvanometers constructed on this principle, namely, the impossibility of balancing the coil for rolling, has been overcome in this form in a simple manner; a piece of thin leaden wire ½-inch in length is soldered at one end to the copper shield of the coil on its lighter side, and by bending this wire or arm, in the required direction, a perfect balance may be obtained in a few minutes to any angle of roll or pitch. Generally speaking, the coil will prove to be too heavy in front, owing to the weight of the mirror. In such case the balancing arm must, of course, be attached



at the back of the coil. For convenience sake, however, it is made heavy enough to slightly outweigh the mirror, the final adjustment being effected by means of a second but lighter radial arm soldered to the coil in front. In this operation the frame need not be removed from the instrument for each fresh adjustment. It will suffice to raise or push it forward a little, so as to allow of the coil and its front radial arm just clearing the gap and being readily handled. Instructions as to the *modus operandi* accompany each instrument.

The figure of merit of the marine type exceeds that of many Thomson marines, but for more delicate measurements on shore, the sensibility of the galvanometer may be augmented ten-fold by suspending the coil freely from above, electrical connection below being completed by a fine non-directive wire spiral.

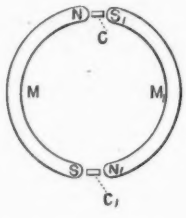


The damping device consists of a fine camel's hair brush, adjustable forward and backward; the holder of this brush fits into a hole pierced horizontally through the frame at right angles to the plane of the coil, and at such an elevation that, when the holder is pushed forward, the brush covers a portion of the upper suspension, more or less closely, according to the degree of damping required.

Index to Parts.

S M = Steel magnet.
C = Coil.
M = Mirror.
S = Sleeve or tube part of suspension frame.
C U = Cylindrical upright.
B H = Brass head
C V = Cover of instrument.
P S & P S_1 = Platinum studs on lower suspension arm.
H B = Hollow base of instrument.
R & R_1 = Suspension rods projecting from coil.
R T H = Rigid torsion head.
S T H = Spring do.
P T & P T_1 = Adjustable pierced tongues through which the suspension rods pass.
L W & B or L W_1 = Leaden wires for balancing coil.
D B = Damping brush.
H = Hole for brush holder.
T = Terminal.
M C & M C_1 = Magnet clamps.

The *double magnet type* consists of two magnets, preferably semi-circular in shape and two coil systems. The magnets are so placed in relation to each other that they form two independent and oppositely directed fields, the north pole of No. 1 and the south pole of No, 2 enclosing one field, whilst the south pole of No. 1 and the north pole of No. 2 similarly enclose the other field, with an independent coil system working in each. See figure, in which the magnets (M, M_1) and the coils (C, C_1) are shown in plan:—



The other details of the instrument are the same as for the single magnet type.

This arrangement affords all the advantages of two independent galvanometers.

Its universality, independence of external magnetic disturbances, and the facility with which it can be adjusted and balanced for rolling render this a very convenient galvanometer, whether for use on board cable steamers, at cable stations, in cable factories, or for general land line and electric lighting work. In equal measure these points commend it for employment in connection with the ever increasing applications of electricity on board warships—more especially ironclads. The sole makers are Messrs. Elliott Bros.

THE NATIONAL TELEPHONE COMPANY'S STAFF DINNER.

There was a goodly muster at the second Staff Dinner, which was held at the Holborn Restaurant, on Friday last.

Mr. James Staats Forbes, the president of the company, originally intended to take the chair, but the influenza ordained otherwise, and the duty fell to Mr. W. E. L. Gaine, the general manager of the company. Although Mr. Forbes was absent, he was made to feel that he was the chairman of a telephone company, for after the excellent fare and the Royal toasts had been disposed of, telephonic communication was established with him at his residence, Folkestone. Speaking to the chairman and the reporters, who were supplied with receivers, he said:—"I am very deeply touched by your kind message. I hope your gathering has been a success. It is a very serious disappointment to me not to be with you to-night. Believe me that I cannot express in adequate terms how highly I appreciate your meeting together, and the presence of our distinguished guests. I find consolation in my absence that the chair is filled by our general manager, supported by Lord Balfour. You, the general manager, will worthily represent the company; and I shall try to follow the proceedings in imagination. But that is a poor way, particularly in the early stages of a festive gathering. It is a real grief to me to be deprived of the opportunity of meeting so many members of our staff; but I am desirous of thanking them in person, and on behalf of my colleagues, for their devotion to the interests of the company. Those at the head of the company know better than anybody else can know what a large proportion of success depends upon the loyal assistance rendered by every member of the staff. Had I been present, I should have liked to impress upon our staff the consideration that we are in some sense a part of the public service of the country, and that in the honourable conduct of that service we have a very high standard to act up to. The difference between us and the other purely commercial organisations that work with a freer hand, and are not charged with quite the same responsibility for upholding and justifying the trust which has been imposed upon them, is very great, and in that we are part of the telegraph service of the State. I am sure I am touching a right chord when I urge all our staff to justify the trust which has been imposed upon us. Please present to all present my respectful compliments, and say that upon such an occasion we do not forget the ladies, whose onerous duties can never be overlooked. Now, with my best wishes, this is all I feel inclined to say."

The Chairman (speaking through the telephone): I wish you, Mr. President, good sleep, pleasant dreams, and a speedy restoration to health. Good-bye, and good night.

The Chairman then proposed "The National Telephone Company," to which Lord Balfour of Burleigh responded.

Mr. Sinclair proposed "Telephony," to which Lord Kelvin responded.

Mr. W. A. Smith proposed "The Post Office," to which Sir Robert Hunter responded.

Prof. Hughes, F.R.S., responding for the guests, said when he looked back only some 40 years to the first printed idea in France, and some 30 years to the birth in Germany of its first telephone, and that it was only 18 years since the idea became really practicable, he was astonished at its widespread success. It was now exactly 30 years since his (Prof. Hughes) first experiments with a working telephone, for in 1865, being at St. Petersburg, in order to fulfil his contract with the Russian Government for the establishment of his printing telegraph upon all their important lines, he was invited by the Emperor Alexander II. to give a lecture before his Majesty, the Empress, and Court at Cyarskoizelo. As he wished to present to his Majesty not only his own telegraph instrument, but all the latest novelties, Prof. Philipp Reis, of Friedricksdorf, Frankfort-upon-Main, sent to Russia his new telephone, with which they were enabled to transmit and receive perfectly all musical sounds, and also a few spoken words, though these were rather uncertain, for at moments a word could be clearly heard, and then, from some unexplained cause, no words were possible. This wonderful instrument was based on the true theory of telephony, and it contained all the necessary organs to make it a practicable success. Its unfortunate inventor died in 1874, almost unknown, poor and neglected, but the German Government had since tried to make reparation by acknowledging his claims as the first inventor, and erecting a monument to his memory in the cemetery at Friedricksdorf.* The duties connected with his (Prof. Hughes's) printing telegraph instrument prevented him from continuing experiments with the telephone of Prof. Reis, but in 1876 they heard of the invention of Prof. Alexander Graham Bell of his telephone, by means of which the practical transmission and reception of human speech had become an accomplished fact, and early in 1877 the instrument was brought to England. He (Prof. Hughes) at once resumed the experiments of 1865 with it, and found that Prof. Bell's telephone considered as a receiver was perfection, but that his mode of transmission of magneto-electric currents, generated solely by the movement of an iron diaphragm near its electro-magnet, was defective, as the currents produced were too feeble for any practical use. He then tried to adopt Prof. Reis's system of using a separate battery brought into play by the movement of a diaphragm. At last he succeeded in finding the effect he wished by the use of a very slight electric contact of the surface of solid carbon, or any other metals, such as ordinary iron nails. This slight or microphonic contact had the remarkable power of varying the resistance, and consequently the force of an electric current exactly in accordance with the sonorous vibrations of the human voice; and, in fact, the contacts could easily be rendered so sensitive that the instrument became a true microphone, rendering audible sounds far too feeble for the human ear. All of these results he gave freely to the public, and brought before the notice of the scientific world in a paper he read to the Royal Society in May, 1878. Another discovery which he made in the continuance of his researches, which is now of the highest utility to far distant telephony was the use of twisted wires. This was given freely to the world in his paper read before the Society of Telegraph Engineers, March 12th, 1879, and fully illustrated by engravings in *Engineering* of the same week. This was the system employed by the telephone line between London and Paris, and in fact upon all successful long distance telephone lines throughout the world. During the same months of 1877, when he was experimenting with Prof. Bell's telephone, Mr. Edison in the United States was also engaged upon a similar research, viz., endeavouring to adopt Prof. Reis's method of transmission by a diaphragm and separate battery—and he succeeded in inventing and patenting his form of transmitter, which he called the carbon telephone. This transmitter was brought to England in 1878, and it worked remarkably well, although he felt convinced that the theory upon which it was supposed to work was wrong. Mr. Edison was, of course, unaware of the power and importance of microphonic joints, else his telephone would have been a practical success. Unfortunately Mr. Edison and himself had a painful discussion as to priority of invention, in which they had both sustained their individual views up to the present time. Mr. Edison's views had been sustained by all the companies owning his patent; his had been sustained by nearly the whole scientific world. The companies, however, whose interest it was to sustain and possess for themselves an entire monopoly, had spared neither wealth nor power to obtain this coveted monopoly, and by the means of the ablest legal counsel and expert witnesses they had obtained a legal decision giving them the sole right to the use of a diaphragm pressing upon a variable resistance, notwithstanding that the diaphragm was the discovery of Prof. Reis, and microphonic contacts by himself. This was all now past history—but he was now more than consoled by the fact, that at the present time there was not a single transmitter in practical use throughout the world whose function was not based entirely upon its microphonic joints, whether in the form of solid conductors pressing upon each other, or when these contacts are multiplied as in the form of granules or powder. He concluded by referring to the progress in telephony which had been due to the telephone companies. The telephone and microphone would have never reached its present vast stage of usefulness if it had not been for the establishment of the exchange system, with its complex and costly system of switchboards.

The toast of the National Telephone Company concluded the list of toasts, and the proceedings terminated shortly afterwards.

New Editions.—Messrs. Whittaker & Co. announce the issue, in a few days, of a revised and enlarged edition of "Poole's Practical Telephone Handbook." We are informed that it is made more complete and up to date by the addition of chapters on Electrical Measurements and Metallic Circuit Working, and a considerable amount of other new matter. The same firm announce the third edition of "Electricity in our Homes and Workshops," by Sydney F. Walker, revised and brought up to date. The chapter on Telephones has been rewritten, and a chapter added, dealing with Dry Batteries. A new edition of Mr. Allsop's "Practical Electric Light Fitting" has recently been issued by the same publishers.

* "Philipp Reis: Inventor of the Telephone." A biographical sketch by Prof. Silvanus P. Thompson, F.R.S., &c. London: E. & F. N. Spon, 1883.

BUSINESS NOTICES, &c.

Ready.—The Universal Electrical Directory. This directory for 1895, which is on sale at 22, Paternoster Row, by Messrs. H. Alabaster, Gatehouse & Co., contains a total of 20,958 distinct names of individuals and firms, being 2,500 more than were contained in the previous edition, and about 8,000 more than any other electrical directory published. In addition to the incorporation of new names, all have been carefully revised, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total of pages in the work is increased by 80, making in all about 866 pages entirely of directory matter. Price 4s.

Ballybay (Ireland).—A movement is on foot here to light the town with electric light.

Birmingham.—At the Council meeting on Wednesday, Mr. Martineau presented the report of the Technical School Committee, and moved that the Committee be authorised to expend the sum of £6,080 in providing electric lighting fittings and motive power at the new Technical School, and that the Finance Committee be instructed to borrow that sum. He had seen a circular which had been sent by Messrs. Fowler, Lancaster & Co. to a select number of the members of the Council. Messrs. Fowler, Lancaster & Co. were lowest in the competition under the first specification, but on the amended specification they were 20 from the lowest in the list of competitors. In their second tender they had added more than £500 to the item for wiring, thereby proving, in the opinion of the committee, either that they had thought better of the quality of the wiring to be used, or that they had made a mistake in their estimate in the first instance. The Council, he thought, would agree that it would be impossible to go back to the less perfect estimate, and give it to the firm which was the lowest. The Electric Supply Company had made a generous offer to the committee, but unless they could give a supply of electric light at 2½d. per unit it would be better for the Council to generate it themselves. Mr. Bradley moved as an amendment that an addition be made to the resolution to the effect that the committee be instructed to accept the lowest tender submitted under the specification originally issued to a select number of firms. Councillor Bradley's amendment was lost, 17 voting for, 35 against, and one member remaining neutral. The resolution of the committee was then carried as a substantive motion, and the report was adopted. We understand that a Scotch firm has secured the contract, being £80 lower than Messrs. Fowler, Lancaster's tender.

Bristol.—The electric light as regards lamp connections is fully realising all the expectations formed by its promoters, and the result of the year's working has so far proved quite satisfactory. There is now laid down at the central station sufficient plant for 24,000 lamps, there being in actual use at the present time about 17,000 lamps. If the increase continues at its present rate the full number will be in use in a comparatively short time, and as that period approaches the committee will have to put down another engine. The full capacity of the building will then be utilised, and the plant will be equal to the supply of 40,000 lamps.

Buenos Ayres.—The Argentina papers contain a detailed description of the electric lighting of the Riachuelo Port, which was inaugurated on the evening of the 15th ult. The existence of the installation is looked upon with general satisfaction, inasmuch as the banks of the Riachuelo have long been the darkest and most dangerous part of the city, and the district has been notable for most appalling crimes. The installation lights both banks of the river from the Barracas Bridge to the Basin on the north and on the south to the workshops of the La Plantense Company. The Company de Electricidad del Rio de la Plata (representatives of the General Electric Company, of United States), are responsible for the installation. This long stretch of the river is lighted by 177 1,200-C.P. lamps, although the original contract was for 200 lamps. The others will be erected later if found necessary. The power station which is situated at Tres Esquinas, was erected by Mr. Bassett-Smith. All the machinery in use was manufactured by the U. S. General Electric Company. The dynamos are of the Thomson-Houston direct-current type, the motive power being supplied by two Babcock and Wilcox boilers. The lamps are of the Thomson-Rice system. The average distance between the lamps is 50 metres on the north side and 65 metres on the south side. Most of the practical work in connection with this installation was carried out under the supervision of Mr. Vernon Lindop. The cost of the work was 54,016 dollars (gold). Mr. W. R. Cassels, the general manager, and Mr. Chevalier-Boutell, the local director of the company, and Mr. Lindop, are much praised by the Buenos Ayres press for their connection with the installation.

Coatbridge.—Mr. Justice Matthew, sitting without a jury in the Queen's Bench, on the 15th inst., had before him the case of Eisler *v.* Marshall and another. In this case Mr. Louis Eisler sued the defendants, Mr. Thomas Shaw Marshall and Mr. John Morrison, to recover damages for breach of an underwriting agreement to provide funds to pay a firm of contractors employed to execute works for lighting Coatbridge with the electric light. The defence was that the underwriting agreement had become abortive, and that the plaintiff was not entitled to recover anything under it. His Lordship eventually gave judgment for the defendants, with costs.

Coventry.—The erection of the electric light works having been hindered by the recent frost, no definite date can yet be fixed for their completion.

Crieff.—An action has been raised in Perth Sheriff Court by W. A. Bryson, electrical engineer, Glasgow, against the Magistrates and Commissioners of Crieff, and Provost Adie, as an individual, for £26 5s., being fee and expenses for providing a report upon the Falls of Barvick water supply for the purposes of electric lighting in Crieff.

Croydon.—Tradesmen and others in the district are to be circularised by the secretary of the Croydon Chamber of Commerce as to whether they will use electric light in the event of it being installed.

Fareham.—No further development has yet taken place in the squabble between the Council and the Electric Light Company. The letter sent by the solicitors to the latter body, to which we have already referred, was, on 12th inst., ordered to "lie on the table," after a lengthy and heated debate. We may have some remarks to make later on this matter.

Hampstead.—The vestry have decided upon the recommendation of the Lighting Committee to employ their own engineer (in lieu of Mr. Preece), to superintend the carrying out of all future work in connection with electric lighting in the parish. Mr. Preece is, however, to be asked if, and on what terms, he will act as consulting engineer until the next annual election of vestrymen.

On 14th inst. current was switched on to the Vestry Hall. The board room has 12 groups of three 16-C.P. lamps.

Hanley.—Application is to be made to the Local Government Board for power to borrow £5,000 required for the extension of generating plant at the central station, repayable in 25 years. The statement of accounts to December 31st show the electric lighting figures to that date as follows:—Receipts £1,574, expenditure £916. Of the difference (£658) there has been appropriated for interest £627, and placed to the reserve fund £31.

Heywood.—The gas manager recently presented a report on electric lighting to the Gas Committee, but that body report that they cannot as yet recommend the adoption of electricity for Heywood. It would be interesting to know what considerations have helped to bring the committee to this conclusion.

Landrindod Wells.—The District Council have invited Mr. Preece (of Messrs. Andrews & Preece) to go down and explain his proposed electric lighting scheme to a meeting of ratepayers.

Leeds.—Current was turned on at the Town Hall early on 17th inst. from the mains of the Yorkshire House-to-House Company. Formerly the corporation generated their own current, but they have now made this alteration because of the nuisance caused by the working of the plant.

Leicester.—The first balance-sheet of the Electric Lighting Department has been submitted. After placing £130 to the reserve fund this only shows a loss of £190 odd up to December, 1894. Out of the £42,748 which they had been authorised to raise, they had only spent, up to the present, £18,882. The total receipts on revenue account, had been £382 15s. 11d., and the gross profit £263 19s. 2d. The present charge per unit is 5d., and it is hoped before the year 1895 ends that they will be able to reduce it to 5d. The present highest demand is only one-sixth of the capacity of the plant. On April 25th it is hoped that the Council and the leading townspeople will be present at the public opening of the station.

Liverpool.—The Special Lighting Committee again last week discussed the matter of the purchase of the Liverpool Company's undertaking, and adjourned with a view to making further arrangements with the company.

London.—The electric light is being installed into Archbishop's House, Westminster. The work has been entrusted to Mr. Frederic Berlyn, of the firm of Roger Dawson, Limited.

The celebrated actor Mr. George Alexander, is having his new house in Pont Street lighted electrically, and has entrusted the work to Messrs. Rashleigh Phipps & Co. This firm is carrying out the wiring for 23 new mansions at Chelsea Court, facing the Embankment, with 50 lights in each, or 1,150 lights in all.

Among the many fine buildings erected in the City, to the designs of the President of the Royal Institute of British Architects, are those of the Guardian Assurance Company and the Clydesdale Bank, in Lombard Street. Both are of course to be lighted electrically. The consulting engineers for this part of the work are Messrs. Handcock & Dykes, of 5, Victoria Street, S.W.

Monmouth.—The Town Council have agreed to apply to the Local Government Board for powers to borrow £30,000 for drainage and electric lighting.

Moss Side.—The proposed electric lighting scheme for the Princess Road Schools has been abandoned, at any rate for the present.

Portsmouth.—Some important extensions are to be made here. A sum of £13,000 is to be spent, and under this scheme the total number of arc lamps in the streets is to be doubled, increasing the total to 200. These will allow of the removal of 920 gas lamps. The new district is expected to bring such an influx of customers that not only will the committee be able to reduce the charges for public lighting by £2 for each arc lamp, but also to supply private consumers at 5d. per unit instead of 6d. It is proposed that this reduction shall take effect from September 29th, and even then the committee will be able to show a net profit of £250. The machinery at the electric lighting station is fully competent to bear the additional burden, and after allowing for the extra arc and incandescent lamps there will still be one large engine to spare. Seeing that the installation is not yet twelve months old this is a splendid record, and the committee, and particularly Alderman Ellis, are to be heartily congratulated on the success that has attended their labours.

Prestwich.—A committee of the local Liberal Club has strongly urged the District Council to consider the advisability of lighting the district by electricity. The matter has been referred to the General Purposes Committee.

Southend.—The Town Council have resolved to try incandescent gas lamps in several parts of the borough. As we have already stated, a committee has been appointed to consider the desirability of installing the electric light.

Tunbridge Wells.—In regard to the paragraph which we published last week about the Town Hall lighting, we are informed that the Mayor did not say what is attributed to him. What he did say was far more complimentary for the electric light. Roughly, he said this: "We could only borrow a certain sum for the electric works, and applications far more than covered what the money we had to spend could do. Consequently the lighting of the Town Hall might rest for the moment, since no money would come in to help the ratepayers by so doing. At the end of the year, when extensions would be necessary, it would be time to consider the question."

Walsall.—The Council have instructed the Electric Lighting Sub-committee to take on lease suitable premises for transformer sub-stations, and to enter into contracts for the supply and erection of two exciter engines and a travelling crane, for the sums of £235 and £106 respectively.

West Ham.—The Town Council have authorised the Highways Committee to bring up for consideration a scheme for lighting the borough by electricity under their 1892 Provisional Order.

Wimbledon.—The contract for the electric lighting of Mr. Bishop's new house at Wimbledon has been placed in the hands of Messrs. Drake & Gorham.

Whitechapel.—The Streets Committee have recommended the Board of Works, in accordance with their 1892 Electric Lighting Order, to establish forthwith an electric lighting installation at the destructor yard. They recommend that Prof. Robinson be appointed electrical engineer to the Board for the purpose of carrying out the installation. When the Board met on 18th inst., the debate was deferred to the next meeting. The cost of the installation is estimated at about £45,000.

A New London Daily.—London is about to have another daily. As its name implies, it will be devoted exclusively to supplying the latest information relating to current tenders and contracts. *Daily Tenders and Contracts* is to consist of four pages Crown broad folio, and will be published every morning. The price will be 2d., and the publishers, the Bouverie Press, 111, Temple Chambers, Bouverie Street, London, E.C. Time will prove whether there is sufficient scope for a daily paper of this class.

Bankruptcy Proceedings.—The receiving order in the case of Jonathan Lewis Young, electrical engineer, late of 52, Fore Street, E.C., was made on February 26th, and accounts have now been issued showing liabilities £3,108 17s. 10d. of which £2,958 17s. 10d. is unsecured, and no available assets. The bankrupt, who filed his own petition, states that he and his brother traded for a short time as "The Edison Mimeograph Company." The bankrupt's brother withdrawing, the bankrupt continued to trade alone until 1892, when he removed to 67, Fore Street, E.C., and formed the business into a limited liability, receiving £500 in shares, with the appointment of manager. He states that he gave the shares to his wife in 1892. Whilst manager to the company above referred to he, in 1893, opened premises in London and Paris for the sale of Edison's phonographs, importing them direct from the inventor's factory. That in consequence of actions brought against him for alleged infringement of patent rights, which he defended at great cost, he was compelled to discontinue business at both places after a few months' trading. It appears from statements made by the bankrupt that he resigned his appointment of manager to the company before referred to in May, 1894, but was re-appointed in December of the same year, and retained the appointment at the date of the receiving order. The bankrupt attributes his insolvency to stoppage of his businesses, in consequence of actions brought against him for alleged infringement of patent rights, and subsequent adverse verdict, which involved him in heavy claims for law costs. With the exception of one claim for £125, the whole of the bankrupt's unsecured indebtedness appears to be due for law costs. No books of account have been produced.

Upon the application of Messrs. Phelps, Sidgwick & Biddle, a receiving order was made against G. F. Rogers, electrical engineer, of 5, Great Winchester Street, E.C., and of 41, Maxilla Gardens, Notting Hill, who has petitioned the court. He states that he holds his office at a yearly tenancy, rent £175; that he has office furniture, £100; and furniture at his private house valued at from £200 to £300. The debts were not stated.

Messrs. Browning and Gardner, electrical engineers, carrying on business at 122, George Street, Edinburgh, as a company, and Ernest Albert Browning and Colin Mackenzie Gardner, the individual partners of said firm, as such partners, and as individuals, will be examined in the Sheriff Courthouse, Edinburgh, March 26th, at 2 o'clock. Creditors meet in Messrs. Lyon & Turnbull's Rooms, 51, George Street, Edinburgh, April 4th, at 12 o'clock.

A first meeting of creditors of William Arthur Jones, electrical engineer and works manager, of 50, Albert Avenue, Newport, was held at Newport last week. The deficiency amounted to £101 14s. 9d., the assets being nil. Debtor attributed his failure to "sickness of wife and family, want of capital, and bad trade."

Business Announcement.—Mr. Th. Lehmann, of Hampshire Street, N.W., has transferred his business, in reference to making the "British Association Standard" screw thread, of which he is the original maker, to his sons, and the business will be conducted at the same address as formerly, under the title of Lehmann Brothers.

Correction.—The name Mr. J. A. "Kinney," which appeared on page 325 of our last issue should read Mr. J. A. Linney.

Change of Address.—Owing to the extension of their business, Messrs. Fuller & Co. will remove to more commodious premises, on March 24th, at 28, Bush Lane, Cannon Street, E.C.

Messrs. O. Berend & Co., have removed from 61, Fore Street, E.C., to the more commodious premises at Dunedin House, Basinghall Avenue, E.C.

Electrical Clock Alarm.—Mr. B. Townley, manufacturing electrician, of Greenwich, S.E., writes us as follows:—"I beg to draw your attention to the fact that the electric clock alarm illustrated in your issue of the 15th is a *facsimile* of my arrangement, the bell of which was a patent, followed by the design of the combination being registered, which was catalogued and exhibited at the Crystal Palace Electrical Exhibition, 1892, where many were sold. I have sold hundreds since both at home and abroad, and have received numerous testimonials. I still make them, and claim to be the sole manufacturer. I can apply the apparatus to any of the arrangements you mention, more so that the clock will sound an alarm after the battery has failed, which is most essential; but I sell it as an electric alarm "only," and desire that it should only be used as such. Apologising on your valuable space, and trusting that you will give publication to this in fairness both to myself and my customers."

Electric Candle Fittings.—Messrs. Laing, Wharton and Down write us as follows:—"In your issue of Saturday last we notice you describe some electric candle fixings which are apparently new to you. We should like to take this opportunity of correcting that assumption, and of informing you that we have for several years manufactured candles which have not only all the advantages pointed out in the candle you describe, but one additional advantage. Our candles have rubber swelling bases so that they may fit sockets with considerably different diameters. They also have a means of holding the candle tube perfectly secure, and, beyond this, can be drawn into two pieces quickly, so that fittings may be dismantled with practically no expense when they have to be packed for shipment or consignment in the country, or else when it is required to pack them up owing to the family being out of town. We should be glad if you would kindly make a note of this fact."

International Building Trades Exhibition.—The Building Trades Exhibition, which opens at the Royal Agricultural Hall on Monday, the 25th inst., is expected to be the most successful held in recent years, both in point of the number of exhibitors and of the varied nature of the exhibits. For the first time in the history of the exhibition, the interest of the Royal Institute of British Architects has been secured, and they will lend models and drawings for exhibition. For the workmen's handicraft competition, the Royal Institute have nominated judges, and the following City companies will also be represented:—Masons, Tylers and Bricklayers, Plumbers, Carpenters. A feature of great interest will be the exhibition of building materials tested for crushing strain by Messrs. Kirkaldy and Son, of Southwark, and the testing of cement in presence of the public by Messrs. Henry Faija & Co., of Westminster. Every inch of the immense ground floor space of the Agricultural Hall will be entirely occupied by exhibits. The promoter of the exhibition is Mr. H. Greville Montgomery, and the offices are at 222, Strand, W.C.

International Telegraphic Codes.—In the House the other day, Mr. A. Morley, in reply to Mr. Henniker-Heaton, said it was decided at the last International Telegraph Conference, held in Paris in 1890, that an official vocabulary should be compiled, and that the use of words taken from that code should be obligatory for code telegrams in the European system at the end of three years from the date of the issue of the book. The three years would expire on December 31st, 1897. The employment of the code outside the European system would be optional. This country and its colonies being parties to the International Telegraphic Convention and the adoption of an official vocabulary, it would not be possible to accede to the suggestion that British merchants should continue to enjoy the privilege of using their own vocabularies, provided that these contained only words taken from the authorised eight languages, and previously submitted to and approved of by the department.

Lazare Weiller & Co.—The publishers of the "Universal Electrical Directory" are sorry to find that in the advertisement of Messrs. Lazare Weiller & Co. in the "Universal Electrical Directory," the name of their representative here has been omitted by the printer. It should have appeared as follows:—Fernand Espir, 3, East India Avenue, London, E.C.

Perry & Co.—The showrooms of this company in 17, Grafton Street, W., were on Monday last visited by the Duke and Duchess of York, for the purpose of selecting electric light fittings.

Price Lists.—Messrs. Joseph Smith & Co., of Thornton Road Saw Mills, Bradford, have sent us a pocket price list of their electric light casing and capping, which they make in ordinary and fancy woods.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—May 1st. Tenders are being invited by the municipal authorities of Tongres, a small town near Liége, for the electric lighting of the public streets.

Germany.—The Alsace-Lorraine State Railway authorities in Strasburg have decided to light the railway station at Thionville by electricity, and are at present inviting tenders for the supply of the necessary plant, including three steam boilers and three compound engines.

Germany.—March 26th. The Cologne (Left Rhine) Direction of the Prussian State Railway Authorities are inviting tenders for the supply of 293 telegraph poles, 10½ tons telegraph wire, 2,500 porcelain insulators, and 2,120 insulator supports.

Spain.—The Municipal Authorities of Tavernernes de Valldigria (Valencia Province) are at present inviting tenders for the concession for the electric lighting of the town during a period of 15 years.

Spain.—April 14th. The General Direction of the Spanish Posts and Telegraphs in Madrid (Calle Carretas No. 10) is inviting tenders for the supply of 20,000 porcelain telegraph insulators, and 76 tons of bronze wire, 3 mm. diameter.

CLOSED.

Ayr.—The tenders accepted for the erection of the electric lighting station are:—Excavator, brick, &c., work, Mr. Robert Hutchison, £3,303 6s. 4d.; Carpenter, joiner, &c., work, D. and J. Milligan, £1,146 13s. 4d.; Slater and plumber work, W. Highet and Son, £356.

Hanley.—The General Purposes Committee have decided to accept the tender of Messrs. S. Z. de Ferranti, Limited, for generating machinery at the electricity works, amounting to £4,033.

NOTES.

The Great Gun Magnet.—When the blessed millenium shall arrive, and the lamb lie down with the lion (not inside him, as usually happens in these degenerate days) our weapons of warfare will have to be converted into various agricultural implements. With this event a difficulty will arise, *inter alia*, regarding the most utilitarian disposition of our great guns. However, if Col. W. R. King, U.S.A., should live to see this day, we have no doubt that he will be ready to meet the difficulty quite satisfactorily. As an earnest of what he can do he has converted a gun, weighing 50,000 pounds and measuring 16 feet in length, into a powerful magnet. What he is going to do with his magnet is another question. In a letter to our contemporary, the *Electrical Review* of New York, Col. King gives some details of the construction of this mighty magnet. The coils extend 8 feet, the cross-section from 300 to 15,000 sq. in.; they involve 10 miles of wire wound in about 5,250 turns. "At a distance of about 71 feet from the muzzle the field created by the magnet is equal to the earth's field, while at 1 foot from the muzzle it is about 338,000 times as strong as the earth's field." From a series of measurements of different distances the deflection of the needle has been determined, and from these results an empirical formula has been deduced, giving the tangents of the angles of deflection as a function of the distance as follows:—$y = \frac{2{\cdot}7}{x^3} + \frac{0{\cdot}2}{x^2}$, in which y is the tangent of the angle of deflection and x the distance in units of 50 feet." Further measurements are to be made "as soon as the weather will permit," and the lines of force are to be carefully plotted. *Et après?* Concerning the particular practical use of this magnet we are not enlightened. It is very wonderful no doubt to put a soldier in front of the magnet and show admiring spectators how the magnet can attract through the soldier's body; and very amusing to watch a squad of men playing at "tug-of-war" with it and calling it an "attraction test." [*vide* the pictures in our contemporary, Vol. xxvi., No. 9, pp. 102-103]; but this is not far removed from what the Yankees themselves call "foolin' around." Let Colonel King go on with his measurements; if he does not succeed in doing anything greater he can at least confirm the observations of others with smaller magnets. And this is something.

Electric Tanning.—Doubtless Mr. L. A. Groth, M.R.I. Stuttgart, has "an axe to grind," and grinds that axe assiduously. Still, for all that, every tanner should read a translation which recently appeared in the *Scottish Leather Trader* of a paper read by this gentleman on January 8th, 1895, at the annual meeting of the Society of German Leather Manufacturers, held at Frankfort A.M. Of course, the subject of the paper was Mr. Groth's own system of converting hides into leather, in which he makes use of electricity as an adjunct. The ordinary tanning processes are, as every one knows, uncommonly slow, and it is Mr. Groth's boast that he accelerates the time necessary for the production of good leather at the expense of none of the qualities of that useful article. We have had occasion, a long while ago, to describe this process in detail; we refrain, therefore, from going over old ground. Mr. Groth has reprinted the translation of his paper in circular form, and whilst pointing out the principles underlying his process, which he claims do not traverse what Prof. Dr. Von Schroeder years ago described as "the golden fundamental theory of tanning," he gives some exceedingly interesting, and we must confess convincing, figures, which are designed to show the superiority of his system over the old-fashioned system in the matter of profit. Assuming that these figures are based upon accurate experimental data, it is clear that every tanner who has any respect for his business must at once lay down Mr. Groth's system of tanning. We admit that we are glad to come to this conclusion, inasmuch as it opens a new direction in which electrical plant may find scope, and young electrical engineers occupation. That the leather produced where electricity is called to the aid of the tanner is as good as any other leather, seems beyond a doubt, and, as we have said before, Mr. Groth's figures are to the non-tanner quite convincing, hence we can but wish him success, and regard him as one of the pioneers of electricity, if not in the highways, in the byways of industry.

Single Track Railways.—Captain Lina Beecher, of Waterport, N.Y., has now, after some years' experiments, been successful in constructing a system of railway construction requiring but a single rail. The road consists of a track having a single T-rail, with two guide rails, 18 inches apart, running horizontally beneath it. The car is provided with two wheels in the centre, bearing on the T-rail, with four guide wheels depending from the car frame, running horizontally with bevel edges upon the guide rails; the use of these guide rails and wheels is to keep the car in an upright position when stationary, or running at a slow rate of speed, and to prevent the possibility of its leaving the track. This is further accomplished by the under flanges on the guide wheels. When the car is running at a speed of over 10 miles an hour, the car runs on the two centre wheels, only touching the guide rails occasionally with a swinging motion. The equipment of the experimental car, which has been operating at Waterport, consists of 50 cells of chloride accumulators, and a 5-H.P. slow speed series-wound motor, together with controlling apparatus. The car, complete, weighs about four tons, without passengers, and has a seating capacity for 24 persons. On a recent trial trip, carrying a load of 23 people, a speed of 19 miles an hour, it was reported, was attained with an expenditure of only 3¾-H.P. A line four miles in length on this system is to be erected from Waterport to Lakeside, in Orleans County, N.Y., and if this meets with success, there will be further extensions, covering in all about 40 miles. Each motor will draw a train of two trailer cars. For a certain distance the road will be operated by water-power, where a dam 40 feet high will be erected for that purpose.

Obituary.—From the *Scientific American* we learn that Mr. Royal E. House died at Bridgeport, Conn., on Monday, February 25th, at the age of 81 years. He was one of the leading inventors in telegraphy, his efforts being principally devoted to the production of a printing telegraph, and to the avoidance of the Morse relay system. In one of his patents he showed what he considered a delicate sounder for a telegraph (an electro-phonetic receiver) line; but it is really a telephone, although House never made use of it to convey speech. This telephone appears in his patent of 1868, and it is one of the curiosities of the history of the telephone.

Engines for Electric Lighting.—Writing to the *Engineer* with reference to an article which appeared in that journal regarding high *versus* low speed engines for electric lighting, Mr. Mark Robinson says that if electricians who like the large slow running engine are as numerous as those preferring high speed engines, they do not appear to adequately back this opinion by their orders. Mr. Robinson says he knows one firm of high speed engine makers who, in 1894, had orders to the extent of 11,205 H.P. for central stations in Great Britain, where the electricians had had previous experience of the same high-speed engines to the extent of 18,626 H.P., and who in the same year had also orders for further 3,710 H.P. for British lighting stations, either newly planned or hitherto working with other engines. He doubts whether the electrical engineers of English lighting stations backed their love for "large, slow running engines," by ordering 14,915 horse-power of that species in the year 1894:—

Fortunately (continues Mr. Robinson), you leave no doubt that one of your reasons is the belief that high speed engines break down more frequently, or more seriously, than low speed engines, and you practically quote a specific instance, saying that Mr. Crompton "will remember one case in which nearly all the various high speed engines in a great installation gave out one after the other, and, in the end, all the work devolved upon certain slow speed engines." I do not wish to arrogate to the Willans engine a higher position than friends and foes alike will give it, but with the exception of one station worked by Westinghouse engines, I do not think there is any "great installation" in this country worked mainly by high speed engines other than the Willans engines, and if any such incident has ever occurred in which Willans engines were concerned, and germane to the question at issue, I should like to hear about it. To the best of my knowledge, there is but one large installation—at Manchester Square—in which there have been successive breakdowns of Willans engines of any serious kind, but the troubles there were of such a nature, and due to such causes, that they throw no light upon the question of high speed *versus* low speed. I feel sure, therefore, you must have something else in view. If, on the other hand, the reference is to other than Willans engines, then it seems to me that the term "high speed" is not employed quite fairly. There is a class of semi-high-speed double-acting engines which, in the opinion of many, exemplify nothing so much as the unwisdom of high speed when not combined with single action and "constant thrust;" but if the reference is to these, it is practically misleading. I am aware that there is also another make of really high speed double-acting engines—that is, engines which have adopted the speeds, or nearly the speeds, of the Willans engines, and which, if employed on a sufficiently large scale, will fairly try the question of single-action *versus* double action, but the use of these in central stations is recent, and I feel sure there have been no such breakdowns with them as your statement refers to. Vague and irresponsible charges that Willans engines are more subject to accidents and require more repairs than other engines are frequently made, but, as a rule, not over a signature, and they more usually take the comparatively safe form of prophecy—if they do not breakdown now they will some day. The evidence is overwhelming that the cost of repairs is, under ordinary central station conditions, astonishingly small, and when such charges are made by the *Engineer*, one looks for a definite basis. As the matter is one of public interest, will you say what "great installation" and what class of engine is referred to?

The editor of the *Engineer* replies to this communication by saying that the remarks complained of did not refer to the Willans engine.

The Northern Society of Electrical Engineers.—There will be a smoking concert at the Palatine Hotel, Hunt's Bank, Manchester, on Friday, March 22nd, at 7.30 p.m.

At a meeting of this Society in Liverpool last Monday, the 11th inst., the following gentlemen were elected members:—E. W. Dickinson, Corporation Electricity Works, Bolton; D. C. Jolley, Corporation Electricity Works, Manchester; W. H. Preece, F.R.S., C.B., Gothic Lodge, Wimbledon.

Some Electrolytic Determinations.—Those who are interested in the application of the principle of electrolysis to the chemical analysis of substances, should not miss two papers which have recently appeared in our German contemporaries. G. Vortmann describes in the *Monatshefte für Chemie*, xv., p. 280, a method of estimating the halogens electrolytically; whilst F. Oettel, whose name we recognise as one frequently occurring in connection with this subject, contributes to the *Zeits. für Elektrotech. und Elektrochem*, vi., p. 192, a paper on the electrolytic determination of nickel and cobalt in ammoniacal solution of their chlorides.

Electric Waves.—Writing to the New York *Electrical World*, Mr. Alfred G. Dell says he has three Bunsen cells of medium size, bichromate of potash being used as a depolariser, and a Ruhmkorff induction coil giving a 1-inch spark. The current from the coil passes into the corner of each of two 12 by 14-inch brass plates, swung by silk threads; the plates are 9 inches apart, and have stiff brass wires (No. 16) extending from the middle of one side of each to a spark gap of pointed gold wires, with rounded, not sharp, points. If the brass wires are pointed they will answer as well, only they are more difficult to keep clean. Back of the two plates there is a plate of sheet zinc extending nearly the whole length of the brass plates and about 1½ inches distant. A piece of sheet zinc, 2 by 3 feet, fastened in a wooden frame, is placed opposite to each of the brass plates, and as near to them as possible without touching; these are brought up until the spark gap just appears between two of the sides, care being taken that they are not close enough for sparks to pass into them from the coil. "As resonators," says Mr. Dell, "I have two circles 2 feet in diameter, made of Nos. 16 and 18 copper wire, one having the wire extending from each side of the spark gap without a break, and the other broken directly opposite the spark gap, the wire being in two pieces, each about 3 feet long; both of these are fastened to wooden crosses. The spark gaps are made of small brass bolts, filled to points, not sharp but rounding, a small brass knob being fastened on each side to give them capacity, and the points being adjustable by means of the screw. With the above arrangement I obtain constant sparking in either circle at great distances, the magnetic and electric forces passing through the floor and walls. I can obtain bright sparking as far as I can go with a circle, provided that it is at all favourably situated relative to the large zinc plates. Such a circle will spark under the conditions given, so that it can be easily seen 40 or 50 feet away, the force passing through the floor and plastered walls. I do not use a lens to see sparking, as it is bright enough to be seen 5 feet or more away at the greatest distance I can go. All Hertz's experiments with circles are thus easily obtained."

An Automatic Mercury Vacuum Pump.—In the Electrical Laboratory at Columbia College, New York, Dr. M. I. Pupin has recently succeeded in perfecting a new mercury pump, which is "new" in so far as it combines two distinct forms of apparatus. First, there is a suction pump, capable of raising mercury practically to any height; and, secondly, there is an ordinary Sprengel pump. The part connecting the two is a syphon barometer properly disposed with respect to the two parts which it connects. All the parts are made of glass, and can be easily constructed by a glass-blower of average skill. Its chief features appear to be its simplicity and its convenience. It has no stopcocks, and it can operate with a much smaller quantity of mercury than is required for ordinary mercury pumps. Dr. Pupin states that the idea was suggested to him by some experiments with vacuum tube discharges. The vacua obtainable by means of it are, of course, the same as those obtainable by the ordinary form of the Sprengel pump. A full description of the *modus operandi*, with a drawing, is given by Dr. Pupin in a paper published in the American *Journal of Science*, Vol. xlix., No. 289, pp. 19—21.

The Electro-Harmonic Concerts.—Next Friday evening will bring to a close the present series of concerts of the Electro-Harmonic Society. So far, they have kept up their high standard of musical excellence, there are no signs of waning popularity, and they seem likely to emulate the example of the "brook," and go on for ever. The last concert—a ladies' night—was memorable in the history of the Society, in that Lord Kelvin, accompanied by Lady Kelvin, made his *début* with striking success, for he wielded the chairman's hammer as if to the manner born. It is to be hoped that members will muster in large force on the evening of the 29th inst., and bring with them fresh candidates for admission into the Society, which is now approaching the end of its ninth season. Mr. Robert Ganthony with his funny sketches, and Mr. Churcher with recitations, are sure to be extremely diverting, and the vocal and instrumental selections will be found worthy of the Society's reputation for good music.

The Measurement of Resistance.—There is a paper by Prof. Arthur Schuster, F.R.S., in the February number of the *Philosophical Magazine*, which is well worth studying. It occurs under the modest title of "Electrical Notes," but is really a paper on the measurement of resistance. The question first considered is that of the limit of accuracy with which the measurement can be made with a given galvanometer and resistance. This is dealt with mathematically. Prof. Schuster then compares the different methods of measuring resistance, and points out that there is really no theoretical advantage of the Wheatstone bridge over any other balance method. However, for all of them, the same limiting value is obtained. When a differential galvanometer is used, the two opposing currents pass through the coils of the instrument, and whenever there is any danger of disturbances in the indications of the needle due to heating effects within the galvanometer, the Wheatstone bridge will have the advantage. But when the resistances to be measured are such that weak currents only can be used, the differential arrangement will possess many advantages. In order to obtain the best effects from a Wheatstone bridge, the resistance to be measured must adjoin one which is small, and one which is great, compared to itself; and these resistances must be constructed so that they are not overheated when the maximum current passes through the resistance which is to be measured. Prof. Schuster, therefore, is of opinion that for measurements of resistance in which a high degree of accuracy is required, the differential galvanometer deserves more attention than it has so far received. If galvanometers can be constructed so that convection currents due to heat effects in the cell containing the suspended magnets can be avoided, it is very probable that the differential galvanometer will often prove to be the most suitable instrument. Prof. Schuster's paper also contains some important matter relating to the construction of bolometers or platinum thermometers.

South African Cable Matters.—There is perhaps no man in the telegraph world of to-day more adept at carrying off Government subsidies than is Sir John Pender. In the last speech delivered by him as chairman of the Eastern Telegraph Company, he informed the shareholders that he had been negotiating for an extension of their subsidy with Cape Colony. He then stated that there were yet five years of their existing subsidy unexpired, but they were hopeful of securing a 10 years' further subsidy, under revised conditions. A despatch from Cape Town now informs us that Sir John's hopes have not been fully realised, the Cape Government having decided to continue to pay the present subsidy of £15,000 a year until December, 1899—the date of expiry of the old agreement—after which the subsidy will be only £6,000 a year. The shareholders, however, are to be congratulated that their company has secured even a £6,000 ten year subsidy. The negotiations which have been in progress between the Eastern Company and the Cape, Natal, and Transvaal Governments, and the Chartered Company for the reduction of the cable tariff, have been concluded, with the result that public messages will pay 5s. a word from April 1st, against 8s. 11d. as formerly. The press rate will be 1s. 6d. per word. The new rates are applicable to all countries in South Africa which are under British and Dutch jurisdiction, but it is not, however, made clear that the reduction of rates applies to telegrams to Portuguese East Africa, and to the British colonies of Seychelles and Mauritius, to which place the existing tariff is excessive. Under this new agreement which, according to the present understanding, is to extend until 1909, the Government reserve to themselves power to determine the agreement by 12 months' notice, expiring five years after the beginning of the extended term.

Accident at the G.P.O.—On Tuesday an accident occurred at the General Post Office, which unfortunately resulted in the death of one man and the narrow escape of another. Two workmen in the electrical department were examining the overnight entries in a book notifying defects to the electric clock, when a four-gallon jar of sulphuric acid, which was close to them, burst, scattering its contents over the men; one of the latter succumbed to his injuries on Wednesday. He leaves four children.

Wire Fence Telephones in Australia.—A correspondent of the *Scientific American*, writing from Victoria (Australia), says, that about two years ago "I satisfactorily utilised the top wire of the existing fences on this station for telephonic use; I have much pleasure in furnishing you with a few items of information. First of all, I may say that since my station was satisfactorily served by this inexpensive method (2s. 6d. per mile) of telephoning, I have been inundated with letters asking particulars from all parts of Australia, and that at the present time there are many hundreds of miles of station fences throughout this and the neighbouring colonies brought into requisition for the purpose. Our climate, as you are aware, is very dry (average rainfall 8 to 9 inches); in consequence, insulation is not such an important matter. On this property we have about 600 posts to the mile of fencing, the wire passing through an auger hole in the ordinary way; the rust that forms on the wire makes a sufficiently thick skin to insulate it from slight moisture. At the straining posts we file the rust off the wire at either side, and tightly screw or key on a piece of clean wire to carry the current around the post; at knots or loop joints we make a continuous connection in the same way. We use the ordinary long distance microphone transmitters at either end, with the dynamo call bells and receivers. In addition, we have a portable instrument, which can be attached to wire at any point when out on the run, and in this way can send messages to the homestead. Our longest service is 16 miles, but one run has a continuous service of 28 miles, and from my experience there is no reason why, in a dry climate, it could not be utilised on much longer lengths."

The Resistances of Electrolytes.—We had occasion a short time ago to notice a paper by M. Wildermann, in which he criticised Kohlrausch's method of determining the electrical conductivity of dissociated compounds. Wildermann concluded that this method was unsuitable for slightly dissociated compounds, and almost useless for organic bases or acids in alcohol or other organic solvent, whilst even when applicable, it is extremely tedious and troublesome. Naturally, Kohlrausch resents this criticism, or, at least, might be expected to defend himself. Consequently we are not surprised to find a paper by him in the *Zeitschrift für Physikalische Chemie*, xv., p. 126, in which he justifies his well-known method of determining the resistance of electrolytes. He is of opinion that the telephone method with alternate currents can be employed for much higher resistances than those examined by Wildermann, and is more convenient and simple than the method of the latter, which involves the use of strong batteries. In cases of much higher resistances, 100,000 ohms and more, he does not consider Wildermann's method sufficiently accurate to render its application useful.

The Production of Palladium in Bulk.—The following paragraph, which we observe in Monday's *Pall Mall Gazette* "Science Notes," is not altogether correct:—

> A glass case containing neither gold, jewels, nor objects of art, yet said to be worth £10,000, was one of the attractions at the Royal Institution last Friday night. The contents were a variety of globules and cast bricks of unpretending appearance, used to illustrate Prof. Roberts-Austen's lecture on the rarer metals and their alloys. A slab of palladium, the largest in the world, was valued alone at £7,000. Prof. Moissan in France, and Mr. Claude Vautin in England have, by different methods, succeeded in reducing and casting these highly infusible metals, most of which have hitherto been seen only in minute and precious fragments; but whereas M. Moissan with his electric furnace has never succeeded in eliminating carbon from his products, which are, therefore, really carbides, Mr. Vautin, by the ingenious use of finely-divided aluminium as a reducing agent, can produce large quantities of almost any one of the metals from their oxides in an absolutely pure condition.

A correspondent considers that the writer was somewhat mixed. He says that "the case of rare metals was lent by Messrs. Johnson & Matthey to Prof. Roberts-Austen, who very frankly alluded to them in his lecture, and said that no other nation in the world could boast of a house who had done the work achieved by Messrs. Johnson & Matthey."

The Telephone Agreement.—The Telephone Committee have chosen Mr. Arnold Morley as their chairman. Official evidence will take precedence, and the first witness examined when the committee meets to-day will be Mr. J. C. Lamb.

Method for Obtaining Alternating Current Curves.—Writing to the *Electrical World*, Dr. Louis Duncan says: "In some cases a telephone method for obtaining the curves of alternating currents and electromotive forces is very convenient. The method ordinarily employed for obtaining current curves is to shunt from a non-inductive resistance in the circuit, and include in the shunt circuit a contact-making arrangement on the dynamo shaft, a telephone, and an electromotive force, due to a constant current. This constant current is adjusted until there is silence in the telephone. When this occurs the fall of potential, due to the alternating current, is equal to the fall of potential due to the continuous current, and knowing the latter, we get the value of the alternating current at the instant the contact on the shaft is made. Electromotive forces may be obtained in the same way by balancing a continuous electromotive force against the instantaneous value of the alternating electromotive force when the contact on the shaft is made. There are several difficulties in this arrangement. Any small thermal electromotive force at the contact makes it difficult to get even an approximate balance, while only one curve may be obtained from a single contact-making arrangement on the shaft. I have employed, with some success, a method in which some of these difficulties are eliminated. To a telephone diaphragm, made preferably of mica, I attach a small coil of fine wire. Beneath the diaphragm are two coils wound together, and so placed, that the diaphragm coil is in a magnetic field, due to currents flowing in them. Through the diaphragm coil I send instantaneous currents, obtained from a contact-making device on the shaft, there being a battery in circuit with the coil and the contact maker. Through one of the stationary coils I send a current proportional to the electromotive force to be measured, or a current obtained from a shunt on a non-inductive resistance in the dynamo circuit. The other coil has a continuous current flowing through it, which latter is measured. I now adjust the continuous current, until the sound in the telephone is zero. If the coils are equal, this will mean that the continuous current is equal to the instantaneous value of the alternating current when the intermittent current is made. It will be seen that the method is independent of any small electromotive forces due to the contact, and any number of curves may be obtained from the same contact-making device. This method is fairly sensitive, and gives good results. It has, however, the difficulty of all telephone methods, that unless the contact only lasts for an infinitely short time, there will always be a sound in the telephone. By making a sharp contact, and after some practice, the results are good."

Damages to a Telegraph Cable.—In the Court of Admiralty the other day Mr. Justice Day, Admiral Sir Leopold M'Clintock and Captain Vyvyan sitting with him as nautical assessors, commenced the hearing of an action brought by the Direct Spanish Telegraph Company, Limited, against the owners of the ss. *Caloric* for damages to plaintiffs' cable whilst in the bay of Bilbao in November last. The defendants' vessel, whilst proceeding from Bordeaux to Bilbao, anchored in the bay, and during heavy weather, dragging her anchor, it was hove up, and, lifting the cable with it, it was cut, partly to rescue the vessel from danger. Defendants denied any negligence, and pleaded that they anchored in a proper and usual anchorage ground, but a gale of heavy violence coming on, accompanied by terrific squalls, she dragged her anchor, and so drew up the cable, which was not buoyed, and of which defendants had no knowledge and, therefore, no reason to provide against. After expending some six or seven hours in investigating the facts, and listening to the legal arguments and submissions bearing on the respective rights of the parties, the Court found for the defendants, holding that the master was justified by the practice in anchoring his vessel where he did.

Medical Electrical Institute, Limited.—In the Chancery Division of the High Court of Justice on Wednesday, the 20th inst., Mr. Justice Vaughan Williams made a compulsory order winding up this company, on the petition of James Willing the younger. Counsel stated that the company took over the business of the Medical Battery Company. No one appeared for the company.

Electric Light v. Limelight.—In a comparison between the electric light and the limelight in their utility and general efficiency as applied to optical projection, Mr. C. Higgs, writing to the *British Journal of Photography*, says that on the score of portability, when the lantern is used for touring purposes, the carting about of the gas cylinders for the limelight becomes a very serious item of expense and trouble (to say nothing of the difficulty in obtaining fresh supplies of gas, which is sometimes experienced), these cylinders being both in weight and bulk considerably more than the cables and resistance frames for the electric light. There has, of course, to be taken into account the fact that, at present, only the larger halls are electrically fitted; but, presuming this difficulty to be overcome, as will probably be the case within the next few years, the advantage on this ground would appear to be with the electric light. It is to be regretted that there does not exist any portable method of storing electricity in sufficiently large quantities, as with the compressed gases. The electric light compares very favourably with the limelight in the initial expense and cost of working. While the light given by the best form of mixed gas jet does not exceed some 250 C.P., the smallest arc that can be successfully maintained would have an intensity of about 150 to 200 C.P., and from this there is a range to some 3,000 C.P., which is considerably more than would be required for the lantern. "In the writer's experience the most useful intensity to ensure a steady light lays between 500 to 1,000 C.P., it being somewhat difficult to keep a good arc with a smaller amount of current; but at this intensity the attention required by a hand-feed lamp is certainly no more than that required by the gases. The electric light cannot well be used for dissolving, unless one of the old form of dissolving arrangements, as used for oil lamps, or the flashing shutters, be used (and this necessitates wasting current for the lamp not in use), any attempt to rapidly switch the current from one lamp to another only resulting in a 'jumping' arc; but with the increasing popularity of single lanterns, this need hardly be taken into consideration. Even using a double lantern, an operator, with some practice, could easily arrange for a minimum of waste. Briefly, therefore, the most useful application for the electric light would be in halls or institutions where the lantern is practically always in use (as for educational purposes), and where the building is already wired, or for use by a lecturer at other halls so fitted, for projection to large dimensions and other purposes requiring an intense light, and for commercial enlarging; while for places where the electric current is not available, and, in fact, for the general run of lantern entertainments, the limelight will hold its own for a considerable time to come."

Failure of Mr. Samuel Elliott.—A couple of months ago the public were invited to subscribe to a company which had been formed for the purpose of working patents which had been taken out for Elliott's Smoke Annihilator. The inventor was to receive £45,000 in cash, and £30,000 in shares. We commented in our issue of January 18th upon the prospectus, and the worth of such a patent, as we considered deserving.

On Monday last, at the London Bankruptcy Court, the failure was announced of Samuel Elliott, joinery and moulding manufacturer, of Broad Street House, E.C., and the Albert Docks, Newbury, Berkshire. The liabilities, secured and unsecured, are estimated at about £80,000. The assets are valued at £3,500, in addition to which the debtor states that "he is the proprietor of a patent smoke and fumes annihilator, which is charged for £23,000."

London-Paris Service.—Owing to recent breakdowns the telephone and telegraph cables between London and Paris are stated to be insufficient to carry the messages that have to be sent, without inconvenience. The pressure of telegraph messages has been such that many have to be delayed several hours in transmission, while the telephone line is so much in demand that it is difficult to secure a turn at the instrument.

Australia and the Pacific Cable.—At the recent meeting of the Postal Conference of the Australian Colonies, held in Tasmania, the Hon. Mr. Thynne, the representative of Queensland, referred to the prices of the tenders received for laying a cable across the Pacific, and said that all the colonies would share in the benefits of the undertaking, which he was certain would prove a financial success, notwithstanding the reduction that would be made in the price of messages. All the bogeys that had been raised to deter the Governments from joining in the undertaking had melted away, and the only question now, was the cost to the revenue of breaking the present monopoly. The Hon. Mr. Ward, Postmaster-General of New Zealand, stated that New Zealand would stand in with the other colonies, Canada, and Great Britain, in establishing a cable, whether it touched New Zealand or not. The colonies were getting more dependent on foreign markets, and it was essential to have low cable rates. After some discussion, the Hon. Mr. Thynne withdrew a motion which he had laid before the conference in favour of an amendment introduced by Mr. Cook to the following effect:—"That the conference re-affirm the desirability of the construction of a Pacific cable, and that in view of its ascertained practicability, the Colonial Governments take steps for the furtherance of the project at the earliest opportunity." This amendment was carried.

Royal Institution.—The following are the lecture arrangements after Easter:—Prof. George Forbes, three lectures on "Alternating and Interrupted Electric Currents;" Prof. Dewar, four lectures on "The Liquefaction of Gases;" Dr. William Huggins, three lectures on "The Instruments and Methods of Spectroscopic Astronomy" (the Tyndall lectures). The Friday evening meetings will be resumed on April 26th, when a discourse will be given by Dr. John Hopkinson on "The Effects of Electric Currents in Iron on its Magnetisation"; succeeding discourses will probably be given by the Earl of Rosse, Veterinary Captain Frederick Smith, the Hon. G. N. Curzon, M.P., Prof. Walter Raleigh, Mr. J. Viriamu Jones, Prof. Alfred Cornu, and other gentlemen.

Rule of the Road at Sea.—Amongst the names of those appointed by the President of the Board of Trade as a committee to consider the report on the rules of the road at sea, we notice the names of Captain Wilson-Barker and Anthony S. Thomson. Both of these gentlemen have had considerable experience in telegraph work in the service of the Silvertown Telegraph Company. Capt. Wilson-Barker is now in command of H.M.S. *Worcester*, the training ship for the mercantile marine.

Lectures.—Prof. W. Robinson, M.E., delivered the first of a course of three lectures explanatory of "The Work of the Electric Current," at the Nottingham University College, last Friday evening. The subject was "The Production and Chemical Action of the Electric Current."

Before the Chesterfield and Midland Counties Institute of Engineers, last week, Mr. Lancelot W. de Grave read a paper on "Continuous Current Dynamos and Motors."

At the Belle Vue Hotel, Bradford, on Sunday night last, Mr. E. Bush delivered a lecture on "Electricity."

Before the Dublin Catholic Commercial Club, last week, Dr. Joseph M'Grath lectured on "The Telephone."

The City Commissioners and the Telephone.—The Commissioners of Sewers seem rather indignant that there is no representative from the City on the Parliamentary Telephone Committee. They have instructed the Streets Committee to make some representations to Parliament through the Remembrancer.

Small Gas Engines for Electric Lighting.—A French contemporary insists upon the advisability of working the electric light by local engines. The writer has just seen, in the north of France, two gas motors put up of 24 horse-power each, and capable of giving 30 horse-power at a push. These give 29 to 30 kilowatts at the cost, per unit, of 37 cubic feet of gas, 12 gallons of water, and 0·0353 lb. of oil. "See to what price that reduces the unit!"

Important Litigation in America.—By a decision just given in the U.S. Supreme Court, at Washington, the telephone and incandescent lamp fields on that side of the water have been thrown open to all manufacturers. The appeal, which was that of the Bate Refrigerator Company, has resulted in what will be a death-blow against the Edison incandescent lamp patent and the Edison telephone patents. The Supreme Court unanimously decided that it is the date of the United States *patent*, and not of the *application*, which controls in determining the bearing of a prior foreign patent. The "Bate case" does not relate directly to electrical matters. The decision, however, has an important bearing on the two Edison patents mentioned above. The suit was known in the courts as Bate *v.* Schwarzchild, *et. al.*, and was a suit on a patented process for preserving meats. The question at issue was the construction of Section 4,887, Revised Statutes, which relates to the life of a patent granted by the United States on an invention for which a foreign government has also granted a patent. The especial question to be decided was whether the date of application for the patent, or the date of issue of the patent in the United States, determined whether or not the life of the patent was to be limited by the term of the foreign patent. The Bate Company brought a suit for infringement of its patent against Schwarzchild & Sulzberger in the Southern District Court of New York. The bill was dismissed upon the defendants' plea that a patent had been issued in England for the same invention between the date of the application for and the issue of the patent in the United States, and that, therefore, the United States patent had expired with the English patent prior to the institution of the suit. The case was carried to the United States Circuit Court of Appeals. That Court certified the case up to the Supreme Court of the United States in respect of the fact that it asked to be instructed upon the proper interpretation to put upon Section 4,887, Revised Statutes. That is, the United States Circuit Court of Appeals asked the Supreme Court of the United States to tell it when did or when does the patent granted to Bate expire in the United States. It is said that the American Bell Telephone Company, which, with the General Electric Company, are credited with being the potent factors in pushing the Bate case to a final conclusion, owns several patents which would be affected precisely as the Bate patent was, depending on the construction placed upon Section 4,887. Our New York namesake considers that now that the agony of the litigation is over, there will undoubtedly be a renewed activity in the incandescent lamp and telephone branches of the electrical field.

CITY NOTES.

The Portsmouth Figures.

We have already said so much about the excellent results which the Portsmouth Corporation Works have shown that it seems unnecessary to comment on the Board of Trade returns which have been just issued. The accounts, however, show that in our article of January 18th, we rather overestimated the actual costs. We pointed out then that the sums put down for fuel included some 80 tons of coal in stock, and that there were certain stores which ought properly to have been omitted. With the accounts before us we can now make the necessary deductions, and the result is that the cost of coal and stores is materially reduced. Including under repairs and maintenance £132 spent on public lamps, the works' cost is 1·99d., while the total costs stands at 2·46d. This is one of the best performances of a municipal station in the first half-year of its existence, and the committee and the engineer deserve great commendation. There is a very small loss after paying off the contribution to the redemption fund, but we have not the slightest hesitation in saying that this loss will next year be turned into a handsome profit.

	1892.	1893.	1894.
Total capital expended ...	—	—	£56,050
Number of units sold	—	—	160,220
Number of lamps connected ...	—	—	—
Revenue from sale of current...	—	—	£3,134
Net revenue	—	—	£1,514
Average price obtained per unit	—	—	4·67d.

Cost of Production.	£	s.	d.	Per unit.
Coal	457	0	0	·68d.
Oil, waste, water, and engine room stores	161	0	0	·24d.
Salaries and wages at generating station	523	0	0	·78d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	192	0	0	(Works' cost 1·99d.) ·29d.
Rates and taxes	—			—
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	312	0	0	·47d.
*Depreciation of buildings and plant account	—			—
Renewal fund account	—			—
Total	£1,645	0	0	2·46d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	3,134	7	2	4·67d.
Meter rents	37	3	4	—
Sale of lamps	—			—
Total	£3,171	10	6	4·67d.

* 1,567 9s. 2d. has been provided out of revenue for redemption of stock.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·46d.; works' cost, 1·99d.

Birmingham Electric Supply Company, Limited.

We have not yet had an opportunity of reviewing the year's work of this company, but through the courtesy of the secretary, we have now received the necessary information to enable us to do so. As we have already announced, the net profit, including a sum brought forward, was £5,609, out of which a dividend of 4 per cent. has been paid, £1,602 has been placed to the credit of the depreciation reserve fund, £250 to the general reserve fund, carrying forward £1,001 to next year's accounts. It will be seen from the subjoined table that there has been a steady increase in the business of the company; but with the new areas of supply obtained by the company, there should be a still greater one in the future.

In spite of the increased output, the cost of coal per unit stands higher by ·1d. than last year; there is, however, a material reduction in the salaries and wages, but whether this is due to any difference in proportioning wages and salaries, we are not in a position to say. Seeing, however, that the sum down for management expenses stands considerably higher than last year, this may be the reason.

	1892.	1893.	1894.
Total capital expended	—	£72,666	£85,577
Number of units sold	—	352,096	396,952
Number of lamps connected	—	10,223	12,128
Revenue from sale of current	—	£9,835	£11,129
Net revenue	—	—	£3,596
Average price obtained per unit	—	6·7d.	6·68d.

Cost of Production.	£	s.	d.	Per unit.
Coal	1,617	0	0	·98d.
Oil, waste, water, and engine room stores	289	0	0	·17d.
Salaries and wages at generating station	581	0	0	·35d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	597	0	0	(Works' cost 1·86d.) ·36d.
Rates and taxes	678	0	0	·41d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,926	0	0	1·16d.
Depreciation of buildings and plant account	1,603	0	0	·97d.
Renewal fund account	—			—
Total	£7,291	0	0	4·40d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	11,128	12	6	6·68d.
Meter rents	329	0	8	—
Sale of lamps	184	9	5	—
Total	£11,642	2	7	6·68d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·43d.; works' cost, 1·86d.

The British Insulated Wire Company, Limited.

The ordinary general meeting of this company was held at the offices of the company in Prescot, March 13th, 1895. Mr. W. Marriner Brigg presided over a good attendance of shareholders. The directors in their fourth annual report and balance-sheet stated that the amount of the net profit, including the balance of £363 14s. 4d. from last year, was £5,751 2s. 9d., after writing off £3,500 balance of formation expenses, and making a liberal allowance for depreciation of buildings, machinery, patents, &c. The directors recommended a dividend of 7 per cent. on the ordinary shares, absorbing £5,067 12s. 8d. (a dividend of 7 per cent. on the preference shares having already been paid to December 31st last), leaving a balance of £683 10s. 1d. to be carried forward to next year. During the year the turnover of the company has more than doubled, and the company now numbers amongst its customers a large proportion of the principal cities and towns and some of the chief railway companies in the kingdom.

The report was adopted.

Thos. Snape, Esq., M.P. was elected a director.

The meeting terminated with the usual vote of thanks to the chairman.

Scarborough Electric Supply Company, Limited.

The third ordinary general meeting was held at the Grand Hotel, Scarborough, on Tuesday, Mr. G. Alderson Smith, presiding.

The Chairman moved the adoption of the report and statement of accounts, which recommended that the credit balance of £418 on revenue account be carried forward. The report was, he considered, extremely satisfactory, considering that this was the company's first year's work. During the first six months of the company's operations they worked at a loss month by month, but in the second six months they not only cancelled that loss, but earned the profit stated. There was a steady progression towards a dividend, which could not be far distant. They had spent £5,385 additional on capital account during the year, including buildings, £822; mains, £2,808; transformers, £1,033; and metres, £563; and as to the future they were committed to the establishment of a new alternator, at a cost of £750; the erection of a foreman's cottage, and the conversion of a superheater into an economiser. It appeared advisable, for the proper extension of the company, to seek the introduction of new capital, which he imagined would easily be forthcoming. They had now 7¼th miles of mains, which constituted one of their heaviest charges, but they were bound to go on progressing in this direction.

Mr. John Bell Simpson seconded the motion.

The report was adopted unanimously.

Eastbourne Electric Light Company.

We have received a copy of the directors' report, which shows an increase in the lamp connection. The net profit is £2,573, after adding thereto the reserve of £295 from last year's profits, and providing mortgage and debenture interest, a balance of £1,540 remains. After setting aside £300 to form the nucleus of a reserve fund, £1,240 is left, which goes to pay a dividend of 7½ per cent. on the shares of the company; the balance of £441 being carried forward. We shall deal with these accounts in our next issue.

The Direct Spanish Telegraph Company, Limited.—The board recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend, free of income-tax, at the rate of 4 per cent. per annum on the ordinary shares, both for the half-year ended December 31st, 1894.

Stock Exchange Quotations.—Application has been made to the Stock Exchange Committee to appoint a special settling day in County of London and Brush Provincial Electric Lighting Company, Limited, 10,000 ordinary and 10,000 preference shares, and to allow the same to be quoted in the Official List.

Royal Electric Company of Montreal.—The Bank of Montreal will pay, on and after the 1st prox., the coupons then due of the 4½ per cent. debenture loan for £120,000.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending March 17th, 1895, amounted to £912; week ending March 18th, 1894, £926; decrease, £14; total receipts for half-year, 1895, £10,823; corresponding period, 1894, £10,400; increase, £423.

The Liverpool Overhead Railway Company. The traffic receipts of this railway for the week ending March 17th, 1895, amounted to £975; corresponding week last year, £707.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 15th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,605.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Pres issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, March 13th.	Closing Quotation March 20th.	Business done during week ended March 20th, 1895. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	101 —104	101 —104	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	41 — 42	41½— 42½	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	78 — 79	78½— 79½	79⅛	77¾
2,993,560£	Do. do. Defd.	Stock	...	...	...	6 — 6¼	6⅛— 6⅜	6⅜	6 5/16
130,000	Brazilian Submarine Teleg., Ltd.	10	6¼% §	6¼% §	...	12½— 12⅝	12½— 12⅝	12½	12⅜
75,000£	Do. do. 5 %, repayable June 1906	100	5 %	5 %	...	109 —113	109 —113	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	10%‖ §	... §	...	3 — 4	3 — 4	3⅛	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	148 —152	148 —152 xd	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	...	1/10— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	13⅛	13½
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	20½	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4 %	4 %	4 %	4 — 4½	4 — 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9½— 10	9½— 10	...	...
30,000£	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	2⅞% §	2 %	8¼— 9	8½— 9	8⅞	8⅝
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6¼% §	6¼% §	...	16½— 16¾	16½— 16¾	16 7/16	16½
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	17½ — 18	17¼— 17⅝	17⅝	17 5/16
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	105 —108	...	...
1,297,837£	Do. 4 % Mort. Deb.	Stock	4 %	4 %	...	124 —127	124 —127	125⅜	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17⅛— 17⅜	17⅛— 17⅜	17⅜	17⅛
54,100£	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	5 %	5 %	...	103 —107	103 —107	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	104 —107	104 —107	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	123 —126	123 —126	125½	...
95,100£	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 }	100	5 %	5 %	...	103 —107	103 —107	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	5 %	5 %	...	104 —107	104 —107	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	4 %	4 %	...	106 —109	106 —109	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	112 —115%	112 —115%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅜% §	4⅝% §	...	9¾— 10	9⅞— 10⅛	10 3/16	9⅝
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	...	16⅝— 16⅞	16⅝— 16⅞	16⅞	16 1/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	...	21¾— 22¼	21¾— 22¼	...	...
190,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	104 —107	104 —107	106½	106¼
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	52 — 54	52 — 54	53	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½%	...	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	6 %	6 %	...	105 —109	105 —109	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	... — ...	... — ...	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	6 %	6 %	...	1½— 2½	1½— 2½	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	5 % §	5 % §	5 %	5¼— 5½	5¼— 5½	5⅝	5 5/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15 — 16	15 — 16	16	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	14½— 15½	14½— 15½	16¼	16⅛
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	5 %	5 %	...	5⅜— 5⅞	5⅜— 5⅝	5¼	5⅜
1,100,000£	Do. 3½ % Deb. Stock Red.	...	3½%	3½%	...	104 — 106	104 —106	105½	104½
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... — ...	... — ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	1/16— 1/8	1/16 — 1/8	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	...	4 — 5	4 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	119 —124	119 —124	123½	121
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	85 — 90	85 — 90	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	0 %	...	4 — 5	4 — 5	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98 —103	98 —103	...	...
64,245	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3½%	10 — 10½	10 — 10½	...	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	5 %	5 %	5 %	6¼— 6⅝	6¼— 6⅝	...	...
33,129	Do. do. do. 5 % Def.	7½	...	...	...	4 — 4½	4 — 4½	4⅝	4½
171,900£	Do. do. do. 6 % Debs. "A," 1910 ...	100	6 %	6 %	6 %	101 —105	101 —105	...	...
214,800£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	6 %	6 %	6 %	101 —105	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅜%	⅝%	⅞— 1⅛	⅞— 1⅛	...	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	6 %	6 %	6 %	10⅜— 11½	10⅜— 11½	11½	11
4,669	Do. do. do. 6 % 2nd Pref. ...	10	6 %	6 %	6 %	9 — 10	9 — 10	9⅜	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	5 %	5 %	5 %	108 —111	108 —111	...	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	115 —120	115 —120	...	...
166,900£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	101 —103	101 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5 — 5⅛	5 — 5⅛	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	13 — 14	13 — 14	13⅜	13⅜
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 15½	15 — 15½	15⅝	15⅛
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —136	133 —136	134	133⅛
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5½%	7⅜— 7⅞	7 1/16— 7 1/16	11⅜	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	2 %	2½%	...	10½ — 11	10¼— 10¾	10⅞	10⅜
100,000£	Do. 5% Deb., bonds of £10, £20, £40	...	5 %	5 %	...	... — ...	... — ...	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	118 —120	118 —120	119¼	118½
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	7¼— 7¾	7¼— 7¾	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	7½%	4½%	6½%	7½ — 8	7½ — 8	7 1/16	7 1/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9	8½— 9	8⅜	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7½ — 8	7½ — 8	7⅛	7 1/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, March 13th.	Closing Quotation, March 20th.	Business done during week ended March 20th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 % §	6 % §	...	2⅜ — 2⅝	2⅛ — 2⅜	2⅛	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2⅜ — 2⅝	2⅛ — 2⅜	2⅜	2⅜
125,000*l*	Do. do. 4½ % Deb.	Stock	4½%	4½%	...	113 —116	113 —116	...	...
630,000*l*	City and South London Railway	Stock	⅝%	⅝%	1¼%	45 — 47	45 — 47	45	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	3 — 3⅛	2¾ — 3¼	...	...
50,000*l*	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	5 %	5 %	...	102 —107	102 —107	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	*nil*	*nil*	...	⅛ — ¼	⅛ — ¼	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	1¼ — 1⅜	1¼ — 1⅜	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	...	... ...	... — ...	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	1½ — 1⅝	1½ — 1⅝		...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	1¼ — 1⅜	1¼ — 1⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	½ — 1½	½ — 1½	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	10 — 11	10 — 11	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	22½ — 23½	22 — 23	22¾	...
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	103 —106	103 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	8½ — 8⅝	8½ — 8⅝	...	...
6,295	† Do. do. Pref., £10 paid	10	...	5 %	5 %	13½ — 14	13½ — 14	...	...
	Swan United Electric Light, Ltd.	...	10 % §	7½% §	...	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	39 — 41	39 — 41	41	40
150,000*l*	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	106½	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2⅜ — 2⅝	2⅜ — 2⅝	2⅛	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—6%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅞—6¼.

Electric Construction Corporation, 6 % Debentures, 84—87.

Electric and General Investment, shares of £5 (£1 paid), 1½—2

House-to-House Company (£5 paid), 3¾—4.

Do. do. 7 % Preference, of £5, 7⅛—⅞.

Do. do. 6 % Debentures of £100, 107—109.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 7½—7⅝; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7⅛.

Liverpool Electric Supply, £5 (fully paid), 7⅝—7⅞.

London Electric Supply Corporation, £5 Ordinary, ⅜—½.

Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 98—100.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5½—6.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

The Electrolysis of Gold. By N. S. Keith, Member. Paper read March 14th, 1895.

(*Continued from page* 338.)

We will consider the subject in its bearing upon the obtaining of gold from auriferous rocks and ores. For this purpose the most important solvent in practical use at present is cyanide of potassium, measured by the production of gold from the mines by its means. It has been stoutly asserted that cyanide of potassium is *not* a solvent of gold, and more surely maintained that it is, by reason of its extensive use for the purpose, spite of the fact that pure solution of potassic cyanide in water will not dissolve gold at a practicable rate, if at all. If, for an experiment, we take a piece of gold leaf and lay it on the surface of a cyanide solution, we will find that it will there be dissolved in a few minutes (the stronger the solution the more rapidly), while a like piece sunk in the solution will be hours in dissolving, the strength of the solution affecting the rate but slightly. It is claimed, and justly too, that the presence of oxygen is necessary for the hastening of the solving action, or, rather, the combination of cyanogen with the gold, so that the resulting auric cyanide be dissolved. This fact was recognised upwards of 50 years ago by Elsner, and the chemical equation was expressed by him thus:

$$4\,Au + 8\,K\,Cy + O_2 + 2\,H_2O = 4\,Au\,Cy\,K\,Cy + 4\,K\,O\,H;$$

the oxygen in this case furnishing the necessary element to decompose some of the potassic cyanide so as to form the double salt, auric-potassic cyanide and potassic hydrate.

MacLaurin, a New Zealand chemist, has proved with mathematical precision the truth of Elsner's equation. His admirable research was published more than a year ago in the *Journal of the Chemical Society* (London), 1893, p. 724.

Gold leaf of the same thickness, and very nearly the same weight, was allowed to remain—

	In stoppered bottle.		In open bottle.		In bottle with O.	
	92	hrs.	68	hrs.	96	hrs.
Water ..	125	grm.	125	grm.	125	grm.
Potassium cyanide	1	grm.	1	grm.	1	grm.
Gold ..	0·9947	grm.	0·99035	grm.	0·99425	grm.
Loss of gold	0·0018 grm. = 0·18%		0·00175 grm. = 0·1%		0·23995 grm. = 24·2%	

The minute quantity of gold dissolved in the stoppered bottle is apparently due to a small quantity of oxygen previously absorbed by the cyanide solution from the atmosphere. Just in the same way water, though not a solvent for calcium carbonate, will dissolve the latter to some extent, if not previously freed from carbonic acid by boiling.

Recognising the apparent necessity of the presence of oxygen, many experimenters have tried many oxidising substances, besides passing air through the cyanide solution, such as peroxide of manganese, ferricyanide of potassium, bleaching powder, or other materials yielding chlorine, bromine and iodine, peroxide of sodium; I have tried peroxide of hydrogen with success. All these are more or less effectual in hastening the solvent action; but as they have to be added in quantities far in excess of the amount theoretically necessary to effect the reactions, if actually brought into contact with the gold and nothing else, they are wasteful, because they decompose more of the cyanide than is necessary for solvent action. Bromine, chlorine, &c., are simply oxidising agents—secondarily, to be sure, but still decomposers of the cyanide in too great quantities, because they exert their action away from the particles of gold. These oxidising agents have been tersely called "cyanicides." Their actions, direct or otherwise, are practically those of oxygen.

Be that as it may; in practice the finely divided auriferous rock, or ores, is submitted to the action of successive quantities of aqueous solutions of cyanide of potassium, containing varying quantities of oxygen, or oxygen-producing materials, or analogues, in large vats, as in infiltration and percolation. Each quantity of the solvent is allowed to remain for a greater or less number of hours in, and covering the ore, and is then drawn therefrom into precipitation vats, where the gold is obtained from the solution by various means, which we will presently consider. Generally, the finely divided auriferous materials are "tailings" from the gold amalgamating mills, which crush and treat with mercury the material for obtaining the contents of gold by amalgamation, as far as possible.

These tailings contain extremely fine-divided gold which has resisted amalgamation, and in varying quantities, averaging about 5 to 6 pennyweights per ton of tailings. Any economy in the above process, such as hastening the rate of solving the gold; prevention of decomposition, as far as possible and feasible, of cyanide; making the gold more easily and cheaply obtainable from the solution, &c., is of vast importance in the metallurgy of gold.

Looking at the matter from the electro-metallurgist's stand-point, some time ago I concluded that the action of oxygen was due to its strong electro-negative relation to gold in a cyanide solution. Therefore I tried the effects of various materials which are electro-negative to gold in solutions of cyanide of potassium. Carbon in contact with gold in cyanide solutions forms with it a voltaic couple,

and the gold is far more rapidly dissolved than when alone. The best practical application of this fact is to finely powder the carbon, and continually agitate it with the auriferous tailings in a cyanide solution. Though the finely powdered carbon causes more speedy action than do a few, or more, large pieces, it is still an operation of chance, because the increased rate of action is dependent upon actual continued contact of gold and carbon until the gold is dissolved. Iron is electro-negative to gold in a cyanide solution. The two form a galvanic or voltaic couple, and the action is the same as in the case of the carbon, only less in speed, because the iron is not so strongly electro-negative as is the carbon. I have discovered that mercury is electro-negative to gold in a solution of cyanide of potassium. I have availed myself of this fact to improve the cyanide solvent, after this manner: I add to the cyanide of potassium solution used for the purpose, in any of its strengths (which latter vary from 0·01 per cent. to 0·5 per cent. of cyanide), a small quantity of potassio-mercuric cyanide ($2\,K\,Cy\,Hg\,Cy_2$), say two ounces, or more, per ton of solution. The action is as follows:—The electro-positive gold decomposes the mercuric cyanide, taking to itself the cyanogen thereof, and receives on its surface the liberated mercury which amalgamates it. Then in the solvent there is the contact of a voltaic couple, under which condition the electro-positive gold is dissolved, and afterwards the extremely attenuated film of mercury again dissolves in the cyanide solution, to react as before. There are no combinations, decompositions, and reactions taking place, except those noted as being caused by the voltaic couple.

There are no oxidations of cyanides to cyanates, which latter are not solvents of gold. The solving action takes place very much speedier, because the electro-negative material is brought into, and retained till dissolved in direct contact with, the electro-positive gold. There is no deleterious material introduced to the solvent, and the mercury acts as an assistant in the subsequent operations of obtaining the gold from the solvent. In the older process, two, three, or more, changes of the solvent were made, with intervals between, during which the oxygen of the air was permitted to permeate the mass of tailings, and thus furnish the necessary electro-negative material. By my electrolytic process, the necessary electro-negative material, mercury, is always present; so that the solution may go on uninterruptedly so long as the necessary solvent, cyanide of potassium, is present in contact with the couple. But, in order to ensure this condition, especially with extremely weak solutions of cyanide, the use of which is desirable, the solvent must be kept in motion through the mass, so that the part containing the cyanogen constituent which should be in contact with the gold may continuously replace the solution which has acquired its *quantum* of gold.

Pursuing the above plan, extremely weak solutions of cyanide of potassium may be used—say 0·01 per centum, or less—by percolating them through the mass of tailings continuously, and simultaneously passing the solvent from the percolator through an electrolytic bath with sufficiently extended electrode surfaces, and enough ampères of current to ensure the electro-deposition of the dissolved gold from the solvent wholly, or in greater part. The solvent can be returned continuously to the tailings to dissolve more gold, if necessary; or, if practically all the gold has been removed, it may be passed to a fresh lot of tailings, to again be passed through the cycle of operations.

The most extensively pursued plan of obtaining the gold from auriferous cyanide solutions is by precipitation by means of zinc. Practice has demonstrated that for effective deposition the zinc must be finely divided, and its surfaces must be bright and metallic, free from oxide or salts. Therefore the "zinc shavings" are always freshly prepared before the time of use.

They are put in boxes having bottoms of iron-wire netting, and these boxes are so placed in the precipitation vat that the solution enters each box of the series through the bottom, up through the mass of zinc shavings, down again, and up through the next box of the series. Having passed through the last box, much of the gold will have been deposited by auto-electrolytic action; and the solution, after being strengthened by the addition of more cyanide, is used to dissolve more gold, as before.

The electro-chemical action is as follows:—The electro-positive zinc takes the cyanogen from the relatively electro-negative gold to form zincic cyanide, which dissolves in the solution, setting free the gold in a finely divided metallic condition. If the action would stop there, this process would not be so objectionable. But owing to the voltaic couples formed by the zinc and gold, there is a further decomposition of the solution, with the formation of oxy-cyanate of zinc, zincate of potash, potassic hydrate, &c. Much of the deposited gold, becoming separated from electric contact with zinc, is redissolved by the cyanide, to be again deposited by more zinc. So it is practically impossible to precipitate all the gold by this means.

If the necessary actions could take place in true electro-chemical equivalents, according to our table, 31·5 troy ounces of zinc would only be requisite to deposit 65·55 ounces of gold. Instead of that, the practical amount, owing to the above-described wastes, and others, is about in the proportion of 1,750 troy ounces of zinc to obtain 65·55 ounces of gold—over 50 times as much as should be necessary. There is something like a corresponding loss of cyanide of potassium. These wastes I have gathered from the data furnished by Eissler in his paper on the "Cyanide Process, &c.," read before the Institute of Mining and Metallurgy on November 21st, 1894. Free alkali, or an alkaline condition of the cyanide solution, is desirable during the solvent action on the auriferous material; but it is undesirable in the zinc precipitation, on account of its solvent action on the zinc, and its tendency to tarnish the zinc, so that the auric cyanide may not readily act on it. On that account the smallest possible amount of alkali is used, when more would be desirable in the solving stage, for decomposing metallic salts, &c., in tailings.

When the depositing vats are cleaned up, the precipitated gold is much mixed with pieces of zinc, insoluble zinc salts, &c. After careful drying, the zinc and gold slimes are treated by oxidising and smelting processes to secure the gold bullion, which is far from fine—say, 700 out of a possible 1,000.

With the object of overcoming the enumerated troubles, and other disadvantages, several experimenters have devised—on paper, at least—electrolytic processes for obtaining the gold from cyanide solutions. So far, the most successful one in extensive practice is that known as the "Siemens & Halske process," which is described in a paper read by Von Gernet before the South African Metallurgical Society some months ago, in the before-mentioned paper by Eissler, and one by Butters and Smart, hereinafter noted. From these I gather the following facts:—

The cyanide solution is treated in four electrolytic vats, each measuring, approximately, 20 × 4 × 8 feet, containing, alternately arranged, anodes and cathodes, which measure each 4 × 8 feet, and are placed so that the solution in flowing through the vat moves downward on one side of each electrode and upwards on the other side, or are so arranged that the solution moves upwards by both sides of several electrodes and downwards by a like number, serially, thereafter.

The anodes are plates, or sheets, of iron, enclosed by canvas, and the cathodes are thin sheets of lead, supported in and by wooden frames. The current of electricity is caused by a dynamo taking 5 H.P. mechanically, and yielding 3½ H.P. in electrical energy at 4 volts pressure. (Von Gernet says 4, Butters and Smart say 10, while Eissler says 7.) According to these data, the electric current may be $\frac{746 \times 3\frac{1}{2}}{4} = 652{\cdot}75$ ampères.

The amount of iron used was 1,080 lbs. in one month, and the amount of gold deposited in that time was 697 oz. 15 dwt. 15 grains. The resulting products are the above amount of gold, some Prussian blue, ferric oxide, hydrogen, and an amount of impure litharge (Pb O) from the cupellation of the lead cathodes: but nothing, except the gold, is of any economic value, because of the expense of reducing the other products to re-workable conditions.

The facts about this process furnish an excellent text for a detailed consideration of the principles involved in the electro-deposition of gold. To begin at the beginning:—

The Vat, or Depositing Vessel.—It is rightly made large, so that it may contain sufficiently extended surfaces of electrodes. It is made of wood, which sufficiently resists any deteriorating action of the electrolyte used in it. The electrodes are rightly arranged so that as the electrolyte passes through the vat, from end to end, it may come, as far as possible, into actual contact with the surfaces of the electrodes. Whether the surfaces are large enough depends upon the amount of electrolyte which passes through the vat in any unit of time, and whether, in its motion, it is brought actually, molecule by molecule, into contact with the electrodes. From the statement of the amount of gold—4 dwts. 8 grains per ton of solution—remaining in the electrolyte after passing through the depositing box, we may doubt the sufficiency of exposure to contact. The cathode surface is stated by Eissler to be 1,566 square feet. But, as it is evident from his other figures that he only took into account one side of the cathodes, the actual surface is 3,132 square feet. This is for one of four "precipitation," or "depositing," vats. So we have 12,528 square feet of lead surface, upon which were deposited 697 ounces of gold in one month. This statement of cathode surface agrees closely with that stated by Von Gernet, and by Butters and Smart in a paper on the cyanide process, read by the latter two before the Institution of Civil Engineers, February 19th, 1895. The iron anode surfaces are 89 × 7 × 3 × 2 × 4 = 14,952 square feet, from which we must deduct 7 × 3 × 2 × 4 = 168 square feet of surface of the end plates not presented to an opposite cathode. The anode and cathode surfaces are about 1½ inch apart. On the whole, the *mechanical* construction of the vat, and the arrangement of its parts, seem to have been carefully considered, and to only err in the amount of electrode surfaces being too small for the *actual* electrolysis which takes place. The *effective*, or *commercial*, electrolysis is a very much less quantity, as we shall presently see. Von Gernet says that a better effect is produced by doubling the surface of electrodes than by increasing the current tenfold.

The *Electrolyte* is, of course, the solution of gold in a liquid composed of water, carrying, also, small percentages of potassic cyanide, potassic hydrate, and various compounds of cyanogen with metallic substances previously existing in the ore which had been treated by the solution, now the electrolyte. By the action of the electric current some ferro-cyanide of potassium is formed in the electrolyte, though much of this is converted into Prussian blue by contact with the oxide of iron formed on the iron anodes. The obvious improvement to be made is avoidance of any iron actions and reactions, because some of them consume electrical energy. The electrolyte is a weak solution at best, and, therefore, specifically, a poor conductor. But, as the quantity is at all times large, the cross section being 6,000 square feet, and length between electrodes but 1·5 inches, the resistance is practically *nil*, and need not be considered. The main consideration as to resistance to electromotive force is that offered by the counter electromotive force of polarisation. The oxide of iron formed on the anodes and in the pores of the bags drawn over them is, as a matter of resistance pure and simple, of some importance.

(To be continued.)

Physical Society, March 8th, 1895.

Mr. Walter Baily, Vice-President, in the Chair.

Mr. Naber exhibited and shortly described a new form of gas voltameter. The chief advantages claimed for this instrument are that either the oxygen or the hydrogen can be collected separately, and that the level of the liquid inside and outside the barette can be

made the same, thus no correction has to be applied to the volume of the gas on this account. Variations in the temperature and barometric pressure are allowed for by reading an air thermometer which is fixed alongside the barette. The inventor considers that this instrument will compare favourably in accuracy with the copper and silver voltameters now in general use. Prof. S. P. Thompson considered that now so much care had been bestowed on the design of a gas voltameter, this instrument might come into more general use than heretofore.

Prof. Minchin gave a short account of a paper by Mr. H. N. Allen entitled "The Energy Movements in the Medium Separating Electrified or Gravitating Particles."

UTILISING ELECTRIC LIGHTING CIRCUITS IN ELECTRO-THERAPEUTICS.

Messrs. Gautier and Larat's Installation. Turning Aside the Current through Shocking-Coils and Transformers.

Two causes have greatly contributed to retard the general employment of electricity as a curative agent. The first is the little importance attached to electrical and electro-physiological phenomena in the study of medicine, to which fact is largely attributable the state of empiricism of electro-therapeutics; the second is due to the great difficulties in the way of the employment of the electrical apparatus themselves. From this last point of view, the utilisation of the industrial currents which are within the reach of all doctors, connected with the lighting systems of towns, gives great facilities; these will gradually become more and more appreciated; we therefore think it will be interesting to call attention here to the methods employed by two of our specialists, Messrs. Gautier and Larat, who have for some years been using the current from the Halles Central Station for feeding their sinusoidal hydro-electric baths. The idea of making use of the water in a bath for conveying the current to a patient is almost as old as the therapeutic applications of dynamic electricity. Up to the present, electric baths have been applied under two forms, the continuous current bath and the faradic bath.*

The first is mainly employed in Germany, whereas the second has been the object of interesting researches to French, English, and Italian doctors. As soon as Dr. d'Arsonval had shown the peculiar effects produced on the system by alternating currents of a definite form—the sinusoidal form—in which, for a given maximum intensity, the instantaneous variations are slightest,* it was to be expected that experimentalists would follow up the idea and apply this new mode of electrifying†. Messrs. Gautier and Larat, who first took up this application, used it successfully in the form of electric baths; by somewhat modifying the method prescribed, they were able by applying the currents distributed through the sector of the city to simplify considerably the apparatus required for the installation of an unlimited number of baths.

The currents used in the electric bath are extremely weak; they seldom exceed 100 milliampères, and for the most part range from about 40 to 60 milliampères, with a tension of 10 to 15 volts; there must therefore be some method of lowering the tension supplied to the circuits (about 100 volts) and a method of graduating the current. The best mode of procedure under these conditions, and one which we have recently recommended for an important installation of the same type, consists in employing one transformer for lowering the tension to 15 volts; this is the maximum voltage required; then for each bath we arrange a transformer with a sliding armature enabling the tension to be varied gradually from 15 volts to 1 or 2 volts. In this way we need not fear shocks resulting from wrong manipulation, and besides it is the combination that most nearly approaches, as a current wave, the form of the electromotive force of the distribution, as we shall presently see. Now, in many cases (the Ferranti machines for instance) this electromotive force is sinusoidal. Messrs. Gautier and Larat, after many experiments, which we need not discuss here, have adopted a slightly different method which works quite to their satisfaction, but which, nevertheless, has two slight drawbacks.

Each bath is provided with an independent installation, consisting of the combination in series of a *shocking coil* (reaction coil) and a little transformer of the type of Dubois-Raymond's chariot induction coils. The whole is placed in a little marble receptacle placed above the bath and at one side of it (see figs. 1 and 2). The secondary of the transformer moves along slides and a rod passing to the outside enables the current to be regulated from a maximum to a minimum. The primary circuit is provided with an interrupter. The wires of the secondary proceed directly to the electrodes, simple plates of metal that can be placed anywhere in the bath by means of suspending hooks. A reversal of this arrangement would have been preferable; the interruption of the primary may, in certain cases, cause a powerful induction shock. The installation has recently been completed by the addition of a Volta milliampèremeter with a large dial for continuous and alternating currents, by means of which the strength of the currents can be estimated with strict accuracy.

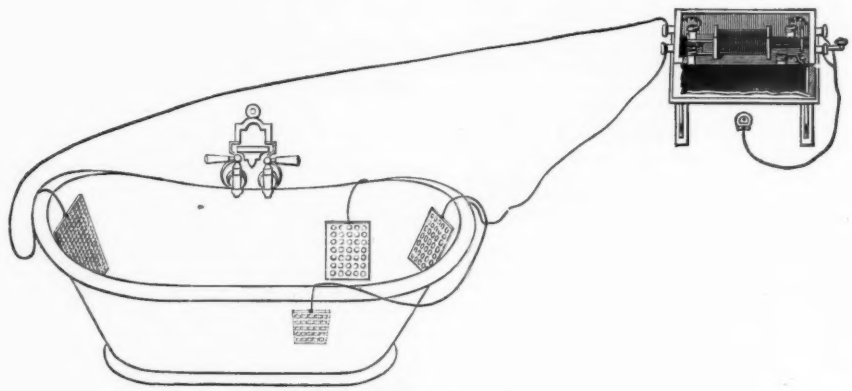


Fig. 1.

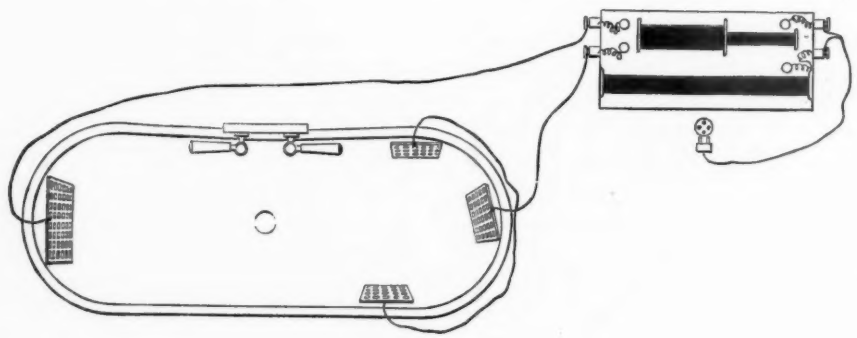


Fig. 2.

A few electrical measurements which Messrs. Gautier and Larat

* Electro-therapeutists, somewhat arbitrarily, often designate by the name, static bath, the application of the silent and obscure discharge of static machines, without the intervention of water.

* The powerful action of these currents on the organic changes is due to the fact that they can be borne in much stronger doses than the faradic currents.

† The employment of sinusoidal currents and the proper methods of obtaining them were patented by Dr. d'Arsonval, June 16th, 1892.

have kindly permitted us to make, have shown us the conditions under which the operations are carried on. Exact data relating to this subject being rarely met with, it may be worth while to reproduce the figures obtained. The first measurement of interest was that of the resistance of the baths, when filled with ordinary water, and also the intensity of the current and the difference of potential at the electrodes. In all the following measurements we have worked with two electrodes only, having a surface equal to about 700 square centimetres. In order to determine the resistance of the water in a bath, we simply introduced into the circuit one of our Volta milliampèremeters, at the same time measuring the tension at the terminals of the circuit constituted by the milliampèremeter and the bath. The resistance of the first being 210 ohms, we found in the first experiment:

$$i = 104 \text{ milliampères}; \quad E = 40{\cdot}5 \text{ volts}.$$

From this we deduce

$$R = \frac{E}{i} - 210 = 180 \text{ ohms}.$$

A second experiment gave

$$v = \frac{91}{1{,}000}; \quad E = 35 \text{ volts and } R = 175 \text{ ohms}.$$

They agree sufficiently closely if we take into account the fact that these two results are deduced from four readings from industrial instruments.

These conditions are not those of ordinary practice; weaker currents are generally used. A measurement made, under what were considered average conditions, by M. Gautier (by the feeling in the bath and by the position of the chariot transformer), gave for the tension at the electrodes (the ampèremeter had to be suppressed so as not to alter the conditions),

$$E = 9{\cdot}9 \text{ volts}.$$

Assuming the mean resistance to be 177 ohms, we find, for the corresponding intensity, 56 milliampères.

The following measurements read from one of the chariot instruments in the position of maximum induction, bring out conspicuously one of the little drawbacks we have mentioned: the secondary does not give a constant voltage (for the same position), but this voltage increases somewhat considerably as the resistance of the secondary circuit is increased, which would happen, for instance, when the bath is being emptied or when the water used is exceptionally pure. Direct contact with the electrodes under these conditions would be disagreeable, if not dangerous.

Voltage of the lighting circuit: 95 volts.

a. Secondary closed on the bath and on the milliampèremeter in derivation (combined resistance about 100 ohms).

Volts at the terminals of the primary of the regulating transformer: 2·7 volts.

Volts at the electrodes: 7·66 volts.

From the resistance of the milliampèremeter (210 ohms and of the bath (180 ohms), we calculate that the total current was equal to 72 milliampères.

b. Secondary closed on the milliampèremeter only (resistance = 210 ohms). Volts at the secondary electrodes: 14 volts; and current = 67 milliampères.

c. Secondary closed on a voltmeter of great resistance (3,000 ohms).

Volts at the electrodes: 32 volts, current about 10 milliampères.

Subsequently, having fitted up a bath room at Dr. Beni-Barde's house with hydro-electric baths on the D'Arsonval system, we resumed these measurements with a view specially to determine what was the resistance of the human body when immersed in the bath. With this object we made three successive experiments.

A. With the subject (Dr. Soulages) in the bath;

B. With the same quantity of water in the bath, without the subject;

C. With the water brought to the same level as in A by the addition of a fresh quantity.§

In all three cases we measured the current, i, by means of a milliampèremeter of 58 ohms introduced into the circuit, and the total tension, E, at the terminals of this circuit; we can then, in each case, deduce the tension, e, at the electrodes of the bath ($e = E - 58\,i$) and its resistance R : $R = \frac{e}{i}$.

We found:

	Milliampères.	Volts.		Ohms.	
A.	$i = 100$;	$E = 19{\cdot}4$,	whence	$R_A = 136$	
B.	$i_1 = 96$;	$E_1 = 19{\cdot}7$,	,,	$R_B = 147$	mean = 151
	$i_2 = 100$;	$E_2 = 21{\cdot}4$,	,,	$R_B = 156$	ohms.
C.	$i_1 = 117$;	$E_1 = 21{\cdot}1$,	,,	$R_C = 122$	mean = 130
	$i_2 = 99{\cdot}5$;	$E_2 = 19{\cdot}5$,	,,	$R_C = 138$	ohms.

If we assume that the water in experiment A preserves the same resistance in B and C, we can, by applying the formulæ of the circuits derived from the experiments A and C, find the resistance equivalent to that of the body of the subject (R_D) and the resistance of the water occupying the same volume (R'); we find:

$$R_D = 1{,}360 \text{ ohms}$$

and

$$R' = 935 \text{ ,,}$$

We may therefore conclude:

That with water of comparatively good conductivity, the human body when submerged offers a resistance somewhat above that of an equal volume of water, and that the current passing through the middle section of the body is equal to about a tenth of the total current,* or 10 milliampères in our case.

This sinusoidal current, the frequency of which was about 40 periods per second (in Messrs. Gautier and Larat's experiments the frequency amounts to 80), must be considered as the maximum for a normal subject; if increased it would set up contraction. For the sake of comparison, we may say that a very strong person would hardly bear a sinusoidal current of 12 to 13 milliampères (frequency = 60) with two large moistened electrodes in his hands; the resistance of the subject under these conditions $\left(R = \frac{E}{i}\right)$ was equal to 2,000 ohms.

An important question that suggests itself, is to know what is the exact form of the current wave in Messrs. Gautier and Larat's method; we shall see, on analysing this problem, that we are led to adopt a somewhat different solution, the one that we recommend above for ensuring the safety of the patients.

The secondary circuit of industrial transformers intended for electric lighting, and which reduce the tension from 2,000 to 2,400 volts to 100 to 110 volts, constitutes a source of practically constant alternating electromotive force, of which the form of the wave may also be considered as invariable. The form of this wave depends on that of the primary electromotive force, or of the electromotive force of the machines. As long as we have to do with practical conditions, *i.e.*, as long as the apparatus are not over-charged, this wave is practically identical with that of the primary electromotive force, with phases in opposition (a lag of 180°)† If, therefore, we have at our disposal a source that is practically sinusoidal as is the case with machines with an armature without iron, and if we proceed to regulate and reduce the tension as we have shown, *i.e.*, by two successive transformations, we can always with apparatus suitably arranged, practically reproduce at the terminals of the baths or electrodes an electromotive force approximating very closely to the sinusoidal form, and, consequently, the current will be sinusoidal. We are going to show by a diagram of a general nature, but applied to the case of the sinusoidal electromotive force, that the fact of introducing a powerful shocking-coil between the transformer of the lighting circuit and the regulating apparatus considerably modifies the form of the currents.

The complete problem, which consists in finding the wave of the secondary current (the bath current) as a function of the electromotive force furnished by the lighting system, in the case of a shocking-coil in series with a regulating transformer, cannot be solved accurately either by the graphic method or analytically; experiment alone, by one of the known methods (Messrs. Joubert's, E. Gérard's, P. Janet's, &c.), would enable the form of the current to be determined. By making two suppositions, pretty near the truth, we may, by successive constructions, find out what would be the secondary electromotive force of the regulating transformer on open circuit.

Now, the wave of the secondary current is identical, if we can assume that the reaction of this secondary current does not appreciably modify the primary current, and the more powerful the shocking-coil is in relation to the regulating transformer, the nearer this is to the truth.

The first problem to be solved would be to find what is the current circulating throughout the shocking-coil and the primary of the regulating transformer. According to the figures we have given, we see that the electromotive force at the terminals of this primary is only a small fraction of the total electromotive force (100 volts); the current is, therefore, determined chiefly by the shocking-coil.

If the shocking-coil is on a closed magnetic circuit, the relation between the flow and the exciting current will be given by one of Ewing's curves, the form of which is well known and which will approach that of curve, A, in fig. 3. Let E (fig. 4) be the curve of the primary electromotive force, we shall find the curve of the flow, F, by integration; in the case of a sinusoidal curve, the curve, F, will be a sinusoidal one, lagging by a quarter of a period, the maximum ordinate of which will be equal to the maximum ordinate of curve, A‡.

The construction enabling the curve $i = f(t)$ to be traced is therefore evident, at the time t, for which E = O, F is at its maximum and corresponds to the maximum of i in Ewing's curve; in order to find the time corresponding to the decreasing flow, A B (fig. 3), we shall bring out $a\,b = a'\,b'$ = A B (fig. 4), then b' A = O B, since to this flow, A B, corresponds the current i = O D. The point A (fig. 4), therefore corresponds to point, A, in fig. 3, and by working thus from point to point, we trace the curve $i = f(t)$ (curve I).§

The fact that two values of F, correspond to the same value of i, according as the flow increases or diminishes, introduces, as we see, a great deflection of the current curve, which would again have been a sinusoid if the flow was always in proportion to the current.

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* Messrs. Gautier and Larat, in an article published in the *Revue Internationale d'Electro-therapie*, quote from their researches and those of Dr. Hedley, the ratio 1 : 5, but without indicating the method by which it was obtained. From what we observed, this ratio might be obtained with a subject offering exceptional resistance. But in such a case, the total current would, of course, be less.

† In fact, there should always be equilibrium between the electromotive force applied and the resultant of the electromotive force induced (which is in proportion to the secondary electromotive force) and the electromotive force required for the passage of the current ($R\,i$). Now, in good transformers, moderately charged, this last item may be disregarded in relation to the first.

‡ The graphic integration of a curve of volts in order to transform it into a curve of flow, always involves the introduction of an arbitrary scale; we may choose it so that the ordinates represent the actual flow passing through the middle spiral and not the total flow passing through all the spirals.

§ Analytically, this amounts to eliminating F between the two equations: $F = \phi(i)$, Ewing's curve and $F = \psi(t) = \int E\,dt$, the curve of flow deduced from the curve of electromotive force.

The curve $i = f(t)$, which we obtain, thus approximates very closely to those obtained by various experimentalists in the United States, in particular, Mr. Ryan, in his researches on transformers. If we wish to take into account the ohmic resistance, we can easily do so by successive approximations, deducting from E the values of $r\,i$; we should then find a new curve of F as a function of t, and we should repeat on this curve the operations made with the first curve, F, &c. A single operation will always be sufficient in practice. The physiological effects of such a current will be very different from those of

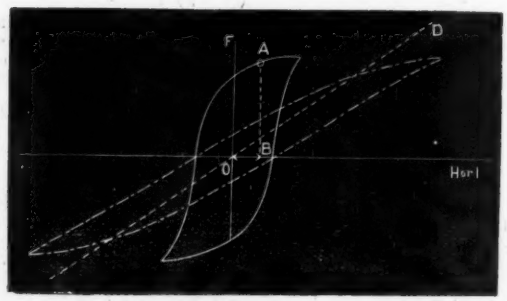


Fig. 3.

a sinusoidal current; the variation from $+ i_{max.}$ to $- i_{max.}$ does not take place regularly; the time required to pass from $+ i_{max}$ to o is much shorter than that required to pass from $i = o$ to $i = - i_{max.}$ When we are trying what conditions must be fulfilled in order to reduce this inequality, we find that we must start from a curve, F, i, much more open; now, this is exactly what happens with shocking coils with an open magnetic circuit. We know, in short, that in order to obtain the curve of magnetisation of a circuit in which a certain *entrefer* is introduced, we must add to the abscissæ those of a certain straight line, O D; we then obtain a curve that is more gentle in proportion as the *entrefer* is greater or the circuit less closed. We have repeated the above construction starting from this new curve (the dotted curve, fig. 3), and we see that the current curve, I', approaches the sinusoid, at the same time retaining the characteristic of a variation that is more rapid starting from the maximum.

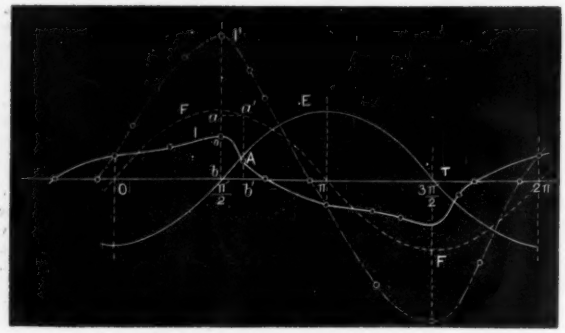


Fig. 4.

We arrive, therefore, at this general result, which is particularly important for the applications of the alternating current to electrotherapeutics, that the more open shocking coils are the less they modify the form of the current, all things else being equal.*

What we have said only applies to the current in the primary circuit. To find the secondary electromotive force of the regulating transformer on open circuit, its curve, F, t, must be constructed, starting from I and the curve of magnetisation of its core, in a similar manner to what we have described; the function derived thus would give the wave of the secondary electromotive force. Without entering into the details of these operations, which would take too long, we will only say that this curve is almost as much altered as the first, unless the cyclic curve of magnetisation is identical with the first, in which case we fall back upon a curve, F, and, consequently, in a similar curve, E. Here, again, there is an advantage in having a transformer with an open magnetic circuit. When the secondary circuit is closed on a resistance so that the number of ampère turns in the secondary circuit is of the same magnitude as the similar product in the first, these constructions are in no way applicable, and experiment alone can give an idea of the form of the secondary current. It would be of interest that this question should be studied from this point of view. —E. Meylan (*Revue Internationale de l'Electricité*).

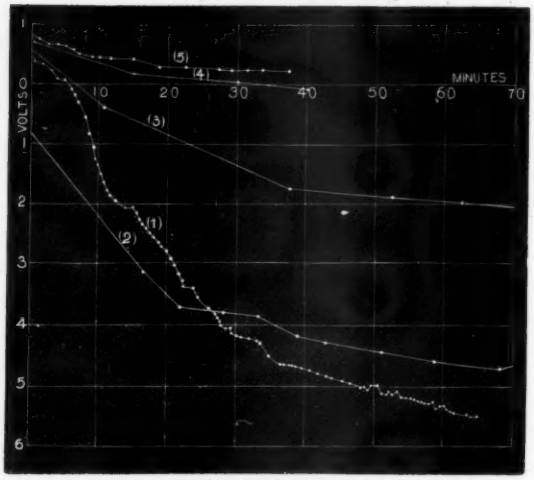
* This reservation is indispensable, for the ratio of the resistance to the mean self-induction must remain the same, otherwise the term, $r\,i$, might preponderate; it is, moreover, probable that the resistance acts in the same direction. If there was only the resistance the curve would not be altered in form.

ELECTRIFICATION OF AIR AND OTHER GASES BY BUBBLING THROUGH WATER AND OTHER LIQUIDS.*

By Lord Kelvin, P.R.S., Magnus Maclean, M.A., F.R.S.E. and Alexander Galt, B.Sc., F.R.S.E.

(*Continued from page* 322.)

Section 10.—At the end of twenty-three days of October and November, 1894, when the air inside the vat must have been fairly free from dust, and when the water-dropper of itself was giving little negative electrification, we bubbled air into it by a forked tube, one end of which was connected to a bellows, and three other open ends were below the water inside the vat. In five experiments thus made—two on November 7th, two on November 8th, and one on December 17th, an average negative electrification of 5 volts in twelve minutes was obtained.



Curves 1 to 5.

Section 11.—We now arranged a U-tube (fig. 4) outside the vat, in which pure water was placed. Air from the bellows bubbled through the water in this U, and was carried thence by a block-tin pipe into the vat without any further bubbling. Observations by the quadrant electrometer, while the water-dropper was running and the bellows worked, gave us measurements of the varying state of the electrification of the air in the vat. The average of fifteen experiments gave a negative electrification of the air in the vat of 8½ volts in 25 minutes. The rate at which the air was blown in in these experiments was such as to displace the entire volume of air in the vat in half an hour.

Section 12.—Curve (8) shows the rate of electrification of air in one of the fifteen experiments when thus bubbled through the water in the U-tube, and then admitted into the vat.

Section 13.—Two U-tubes, in series, with water in each, did not seem to give a perceptibly cumulative effect.

Section 14.—The effect of one or more wire gauze strainers between the U-tube and the vat, or between the U-tube and the bellows, was next tested. The gauzes were placed between short lengths of lead tube, which were held together by a rubber tube slipped over them. The arrangement is shown by longitudinal and cross sections in fig. 5. Twelve wire gauzes, with or without cotton-wool between them, placed between the bellows and the U-tube, did not prevent the subsequent electrification by bubbling of the air thus filtered. But when placed between the U-tube and the vat they almost entirely dis-electrified the air, even without the cotton-wool, and still more decidedly when cotton-wool was loosely packed between the wire gauzes. A single wire-gauze strainer produced but little of dis-electrifying effect.

Section 15.—The interpretation of these experiments is complicated, and the time required for each is lengthened, on account of the large mass of air in the vat to start with, whether uncharged or retaining electricity from previous experiments, and also on account of the effect of the water-dropper itself. Hence, in our later experiments, we fell back on the arrangement shown in fig. 2, by which we test the electrification of the liquid, and not directly that of the gas blown through it.

Section 16.—In our first experiments with this apparatus the amount of the electrification did not seem much affected when a paper cover was put on the beaker, or when we tilted the beaker as shown in fig. 3. We now made a large number of tests with different covers and screens (chiefly of sheet copper or sheet zinc, or brass wire gauze) at different heights above the liquids, and we conclude that, if the screens are not within a centimetre-and-a-half of the liquid surface, they do not directly affect the magnitude of the electrification obtained. In nearly all of the subsequent experiments

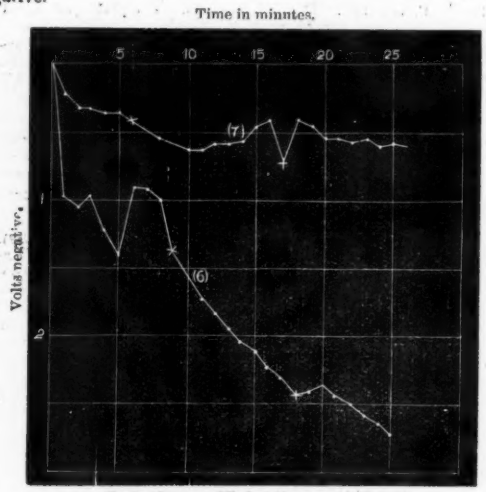
* Received February 7th and February 15th, 189

a horizontal circular screen of thin sheet copper, leaving an air space of about 3 mm. all round between its edge and the inner surface of the jar, about 3 cm. above the liquid surface, was used to prevent spherules of the liquid from being tossed out of the jar by the bubbling.

Section 17.—In the following short summary of our results the duration of each experiment was 10 minutes. The effect of blowing air through water and other liquids is summarised in 18 to 27, and of blowing other gases than air through water in 28 to 31.

Section 18.—The jar contained 200 c.c. of the Glasgow town-supply water (from Loch Katrine). A mean of seventeen experiments showed an electrification of the jar to 4 volts positive when air was blown through it for 10 minutes.

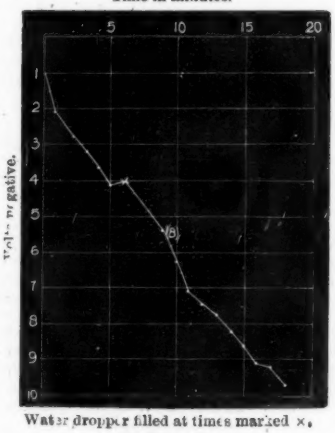
Section 19.—A solution of zinc sulphate of different strengths was now used instead of the pure water. Three experiments, with 150 c.c. of water containing one drop of a saturated solution of the zinc sulphate, gave half the positive electrification that would, under similar circumstances, have been obtained from water only. With five drops no definite electrification was obtained. With greater proportions of the zinc sulphate solution up to saturation (twenty-four experiments altogether) the electrification was on the average slightly negative.



Water dropper filled at times marked ×.

Curves 6 and 7.

Section 20.—Twelve experiments were then made to test the effect of adding a solution of ammonia to the water. One drop reduced the electrification to one-half; two drops brought it down to one-quarter. With larger proportions of ammonia than this, up to a saturated solution, we found a very slight positive electrification,



Water dropper filled at times marked ×.

Curve 8.

never amounting to more than a small fraction of a volt, and therefore negligible in the circumstances.

Section 21.—Additions of very small quantities of washing soda to water greatly reduce the positive electrification obtained.

Section 22.—Ten drops of paraffin oil added to water reduced the electrification to about half of that obtained from water only. 30 drops reduced it to about a tenth, which as it amounted to only 0·4 volt during the time of the experiment is negligible.

Section 23.—Ten drops of benzene reduced the electrification to half, and 30 drops to about a third of that taken by pure water.

Section 24.—A saturated solution of granulated phenol (carbolic acid) was made, and small portions of it added to the water in the jar. Several experiments showed no diminution in the electrification as long as the quantity of the phenol solution present in the water was under 10 per cent. With 25 per cent. the electrification was reduced to a third. With strengths greater than this up to saturation the electrification was reduced to one-sixth.

Section 25.—A saturated solution of common salt was prepared. Blowing air through 200 c.c. of water containing the quantities of the salt solution mentioned, gave us in 10 minutes the following electrifications:—

		Volts positive.
(*a*)	0·004 per cent. of saturated solution of salt in water ...	2·4
(*b*.)	0·02 " " ...	1·2
(*c*.)	0·1 " " ...	0·6
(*d*)	0·5 " " ...	0·4
(*e*.)	2·0 " " ...	0·15
(*f*)	4·0 " " ...	0·0

Section 26.—Several experiments showed that with 200 c.c. of water containing not more than 10 drops of absolute alcohol, practically the same amount of positive electrification (4 volts in 10 minutes) is obtained as if pure water were used. With 50 drops less than 2 volts were got, and with 100 drops less than 1 volt. 25 and 50 per cent. alcohol in the water gave very small and hence negligible positive electrification.

Section 27.—One drop of saturated solution of copper sulphate in 200 c.c. of water showed 1 volt positive in 10 minutes. With one-half per cent. of copper sulphate in the water, the electrification was reduced to a fraction of a volt positive. With greater proportions of copper sulphate present, up to saturation, slightly negative electrifications were obtained, but never amounting to more than about one-tenth of a volt, and hence negligible.

Section 28.—On blowing carbonic acid gas from a cylinder obtained from the Scotch and Irish Oxygen Company, through pure water in the glass jar, the water became electrified to 8¾ volts positive in 10 minutes. Blowing the breath through water gave an electrification of 3 volts positive in the same time; this diminished result is doubtless due chiefly to the diminished rate of bubbling.

Section 29.—The blowing of oxygen from a cylinder, obtained from the Oxygen Company, through water, gave as a mean of four experiments a positive electrification to the water of half a volt in 10 minutes. When continued for 55 minutes, it gave the very decided result of 5 volts positive.

Section 30.—Hydrogen prepared from zinc and dilute sulphuric acid was passed into a large metal gas-holder; and was passed on from this to bubble through the water in the insulated jar. In two experiments this was done immediately after the preparation of the hydrogen; in another it was done after the hydrogen had remained 18 hours in the gas-holder. In each of the three experiments the water was electrified to 2 volts positive in 10 minutes.

When the hydrogen was allowed to pass direct through a tube from the Wolffe's bottle where it was generated, to bubble in the insulated jar, the magnitude of the effect obtained was very much larger. In one case a mixture of muriatic acid and sulphuric acid and water was used, and the reading went off the scale positive in 30 seconds (more than 10 volts). In the other two experiments with dilute sulphuric acid and zinc in the Wolffe's bottle, the electrifications obtained were 6 volts positive in seven minutes, and 7·3 volts positive in 13 minutes, in the last of which the hydrogen was allowed to bubble through caustic potash contained in a small bottle between the Wolffe's bottle and the insulated jar.

The hydrogen was next generated in the insulated jar itself, the tube for ingress of air used in the ordinary experiments being taken away. 200 c.c. of pure water, along with some granulated zinc, was put into the jar. Then some pure sulphuric acid was added, and electrometer readings were taken. In two experiments with no screen in the jar (16) the reading went off the scale negative (1) in two minutes, and (2) in four minutes (more than 9 volts in each case). In another experiment in other respects the same, but with a copper screen 7 cm. above the surface of the liquid, the electrification showed two volts *negative* in two minutes, then came back to zero in five minutes, and in the next six minutes went 4 volts *positive*. The jar and pair of quadrants connected with it were then metallically connected with the outer case of the electrometer for a few seconds, and reinsulated; in five minutes the reading went up to 2 volts *positive*. A little more sulphuric acid was added to the jar, which was disinsulated for a short time and reinsulated; the reading went up to 7 volts *positive* in four minutes. The jar was again disinsulated for a few seconds and reinsulated; the reading went up in 4½ minutes to 6½ volts *positive*.

Section 31.—Coal-gas gave 1·4 volts positive in 10 minutes.

Section 32.—The following experiment was tried several times. One of us stood leaning over the jar, with the head about 10 inches above it, and the mouth so partly closed that breathing was effected sideways; another blew the bellows, and another took the readings of the electrometer. After bubbling had been going on for some minutes, and the readings were rising gradually (4 volts per 10 minutes, as in section 18), blowing was stopped. As soon as the bubbling ceased, the first-mentioned observer, without moving his head or his body (see section 7, regarding the necessity to have the electrometer screened from outside influences) blew into the jar to displace the negatively electrified air in it. In every case the electrometer reading showed instantly a small rise in the positive direction.

In the carrying out of these experiments we have received much valuable help from Walter Stewart, M.A., and Patrick Hamilton, B.Sc.

Section 33.—The very interesting experiments described by Lenard, in his paper on the "Electricity of Waterfalls,"* and by Prof. J. J. Thomson, on the "Electricity of Drops,"† show phenomena depending, no doubt, on the properties of matter, to which we must look for explanation of the electrical effects of bubbling described in our

* *Wiedemann's Annalen*, 1892, Vol. xlvi., pp. 584—636.
† *Phil. Mag.*, April, 1894, Vol. xxxvii., pp. 341—358.

present communication, and of the electrification of air by drops of water falling through it, to which we have referred as having been found in previous experiments which were commenced in 1890 for the investigation of the passage of electrified air through tubes.*

NEW PATENTS—1895.

16,156A. "Improvements in electric locomotives chiefly designed for use in mines." B. Lebrun. [Date claimed under Patents Rule 19, August 24th, 1894] Dated March 9th.

4,551. "Electrical cut-outs." E. A. Claremont. Dated March 4th. (*Complete.*)

4,557. "Conduit electric railway." L. C. Pressley. Dated March 4th. (*Complete.*)

4,566. "Improvements in the construction of fences, and the apparatus for straining and tightening the same, and the posts and pillars for the same, which improvements are also applicable to all hauling, straining, and tightening purposes, and to telegraph, signal, and similar poles or posts." W. C. Morton and E. Franklin. Dated March 4th.

4,576. "Improvements in electric motors." A. H. Brintnell. Dated March 4th. (*Complete.*)

4,577. "Improvements in or connected with apparatus for electrically lighting miners' safety-lamps." W. Ackroyd and W. Best. Dated March 4th.

4,593. "The pen's electric illuminator." H. W. Cobb. Dated March 4th.

4,610. "Improvements in or relating to secondary batteries or electric accumulators." W. A. Boese. Dated March 4th. (*Complete.*)

4,623. "Electrical method of closing the air-exhaust apertures of hermetically sealed canisters and like vessels." G. W. Davey. Dated March 5th.

4,658. "Improvements in demagnetising apparatus." C. Houlgrave. Dated March 5th. (*Complete.*)

4,660. "Improvements relating to the electro-deposition of iron on copper or other metallic surfaces." A. Hiorns. Dated March 5th.

4,670. "Improvements in electric apparatus for igniting and extinguishing gas jets simultaneously from a distance." O. von Morstein. Dated March 5th. (*Complete.*)

4,672. "Improvements in telephone and telegraph systems." H. H. Lake. (Communicated by C. A. Shea and F. F. Raymond, United States.) Dated March 5th.

4,685. "Improvements in commutator brushes." F. H. L. Blanken. Dated March 5th.

4,697. "Improved electric signalling apparatus for railways." G. A. Lyncker and A. Schropp. Dated March 5th. (*Complete.*)

4,770. "Improvements in apparatus for measuring electricity." E. H. P. Humphreys. Dated March 6th.

4,851. "Automatic replacement fuse for electric lighting." W. Cole. Dated March 7th.

4,873. "Improvements in connection with electrical insulating materials." T. P. Wiggins and G. H. Wiggins. Dated March 7th. (*Complete.*)

4,939. "Indirect electrolysis." E. Andreoli. Dated March 8th. (*Complete.*)

4,941. "Improvement in pushes for electric bells." R. J. Dale. Dated March 8th.

4,979. "Improvements in wall plugs for electrical connections." H. W. Young. Dated March 8th.

4,980. "Improvements in dynamo-electric machines and motors." L. B. Atkinson. Dated March 8th.

4,987. "Improvements connected with arc lamps." J. J. Rathbone and The "Harp" Arc Lamp Syndicate, Limited. Dated March 8th.

5,003. "Improvements in electric condensers." S. Z. de Ferranti. Dated March 9th.

5,004. "Improvements in apparatus for regulating and controlling electrical circuits." H. Dickinson. Dated March 9th.

5,031. "Improvements in electricity meters." F. F. Yeatman. Dated March 9th.

5,041. "Electric steering-gear." Siemens Bros. & Co., Limited, and G. S. Grimston. Dated March 9th.

5,058. "Improvements in or applicable to electric arc lamps." R. J. Rae. Dated March 9th.

5,059. "Improvements in and relating to electric accumulators." A. Oblasser and C. Theryc. Dated March 9th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

1,164. "Improvements in armatures of dynamos and electric motors." H. Penn and L. Lowndes. Dated January 19th. Relates to an improved method of constructing armatures of dynamo-electric machines and electric motors; in which the armature is built up of sheet iron discs or rings, suitably separated from one another, each disc or ring being corrugated radially: these discs or rings are pressed together by end plates suitably shaped to fit the corrugations in the discs or rings; the end plates being keyed or otherwise secured to the shaft, and the necessary pressure obtained by screwed nuts or nuts and bolts. In addition to the end plates one or more plates shaped to fit the corrugations in the discs, and keyed or feathered to the shaft may be introduced at convenient intervals. 1 claim.

11,439. "Improved electric indicator or signal." H. J. Wagg. Dated June 13th. A box divided into two or more spaces has pieces of glass let into the front; one in front of each space, on the inner side of each piece of glass, some semi-transparent paper is fixed, on the face furthest away from the glass of which, a word is painted or printed. In each space is an electric glow lamp, all of which are connected in series with a battery, a push, and one contact of a two or more way switch, according to the number of lights; the push is fixed on, or by the box, and the battery and switch where desired. On setting the switch to a certain contact the space in the box corresponding to that contact, will, on pressing the button, be lit up, and the word on the glass will be revealed. 3 claims.

12,345. "Improvements in transformer systems of electrical distribution." P. Wright. Dated June 26th. The principal objects of the present invention are to provide simple, compact, and efficient mechanical and electrical devices for permitting of the interruption of the primary circuit in cases where the lamps, lights or other translating devices of the secondary circuit are not to be employed for a considerable time, for example, in the case of churches, halls and the like, and, third, to provide reliable, durable, and comparatively inexpensive means for automatically interrupting, first, the secondary circuit and then the primary circuit and for closing, first, the primary circuit and then the secondary circuit of two or more transformers, whereby one or more of the transformers is cut into or out of action according as more or less lights, lamps, or translating devices are employed, thus effecting a material saving. 19 claims.

13,499. "Improvements in process and apparatus for electrolytical decomposition of alkali salts." A. Sinding-Larsen. Dated December 12th, 1893. (Under International Convention.) Relates particularly to the electrolytical processes in which mercury is employed as a means of transporting the metallic constituent, separated from the salt in solution under treatment, from the field of electrolytic action into contact with a solvent being capable of depriving the mercury of the metal amalgamated with it. It consists in introducing in the mercury acted upon by the electrical current a metallic body having an amalgamated surface and having part of the same also in contact with the solvent agent. This metallic body is rotated or otherwise moved, so that the amalgamated mercury adhering to the part of the body dipped in the mercury will be carried with the body or driven along the surface of the same in a very thin layer up towards and through the solvent agent. 6 claims.

13,995. "Improvements in or relating to electric railways." W. P. Thompson. (Communicated by J. F. McLaughlin, of Philadelphia.) Dated July 20th. Includes certain improvements in the construction of the conduit, the travelling contact or switches, and the operating magnets. 13 claims.

14,069. "Improvements in electrical governors for water wheels." C. S. English. (Under International Convention.) Dated December 23rd, 1893. Has for its object to provide novel mechanism for automatically regulating the supply of water to a water wheel that is utilised to generate power for an electric dynamo, in such manner that the amount of water supplied to the wheel, and, consequently, the power developed by the wheel, shall be increased and diminished in proportion to the amount of work required to be performed by the dynamo. 5 claims.

14,202. "Improvements in signalling by electric lamps." H. D. Fitzpatrick. (Communicated from abroad by The Boughton Telephotos Company, of Buffalo.) Dated July 24th. The object of the present invention is to perfect and add a particular construction and arrangement of operating parts which connect the keys with the lamps. 19 claims.

14,240. "A new or improved electrical apparatus for calling or waking persons in different rooms at different determined times." W. Wilke. Dated July 24th. Claim:—1. The electrical apparatus for calling or waking persons in different rooms at different determined times, consisting of the combination of the hour hand of a clock, and the spring, which constitute, together with the insulator, a device operating regularly in an electrical circuit, of which it forms part, so as to make and break at regular or irregular intervals of time, communication through an electric battery, with bells in any number of rooms, by means of the movement of the spring over the ends of the conducting wires, which correspond with the required divisions of the several hours, in combination with separate conducting wires, by which at the exact time required, the conducting wire corresponding with such time can be electrically connected with the bells in any one or more of the rooms, substantially as described and illustrated.

15,506. "Improvements relating to voltmeters, which are applicable to ampèremeters." F. Brown. Dated August 15th. Consists essentially in an arrangement whereby the core constituting the movable and fixed electro-magnets may be attached or detached from a volt or ampèremeter in a more efficient and expeditious manner than heretofore. 2 claims.

16,408. "Improvements in printing telegraphs." R. A. Fowden. Dated August 28th. Has relation in general to the printing telegraph system, Patent No. 22,856, November 28th, 1893; and it relates more particularly to certain improvements in the construction, arrangement, and operation of the mechanical and electrical devices and circuits of such system. 23 claims.

* "Electrification of Air by a Water Jet." By Magnus Maclean and Makita Goto, *Phil. Mag.*, August, 1890, Vol. xxx., pp. 148—152.